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ABSTRACT

In 1980 1,455,000 persons worked in computer occupations. Two in five were systems analysts or programmers; one in five was a keypunch operator; one in 20 was a computer service technician; and more than one in three were computer and peripheral equipment operators. Employment was concentrated in major urban centers in four major industry divisions--manufacturing; services; finance, insurance, and real estate; and wholesale and retail trades. Between 1970 and 1980, employment of computer workers more than doubled. Educational requirements ranged from high school graduates to those with a college degree and beyond. The shortage of qualified computer workers is due to the relative newness of the field, its rapidly changing technology, and lack of qualified teachers. Overall employment is expected to increase by nearly one-half from 1980 to 1990. New technologies that will affect employment are in three major areas: hardware, software, and applications. Employment of computer and peripheral equipment operators and computer service technicians is expected to increase, while the demand for keypunch operators will decrease. The shortage of computer personnel is expected to continue, resulting in higher wages, more job mobility, increased job security, and greater opportunities. (Appendixes include data tables and a glossary.) (YLB)

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Employment Trends in Computer Occupations

U.S. Department of Labor
Raymond J. Donovan, Secretary

Bureau of Labor Statistics
Janet L. Norwood, Commissioner
October 1981

Bulletin 2101

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Preface

This bulletin presents the results of a Bureau of Labor Statistics study of employment of workers in five computer-related occupations. It includes information on education and training for computer occupations, the impact of advancing technology on employment and education, and projected employment requirements through the 1980's. The study was conducted as part of the Bureau's program to provide information about occupations for use in career counseling and education planning.

The bulletin was prepared in the Division of Occupational Outlook under the direction of Michael Pilot. Patrick Wash supervised its preparation. H. Philip Howard and Debra E. Rothstein conducted the research, analyzed the data, and wrote the report. Vidella H. Hubbard prepared the manuscript. The Bureau is grateful to the many individuals who provided information for the study and who reviewed and commented on the draft report.

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Contents

Page

Highlights 1

Chapters:

1. Employment 3
   - Geographic distribution 3
   - Industries of concentration 3
   - Industry trends, 1970-78 3
   - Occupational trends, 1970-80 7
2. Education and training 11
   - Current requirements 11
   - Post-employment training 12
   - Current status of education and training 12
   - Evolution of education and training 13
3. Projected employment requirements 18
   - Technological factors affecting growth 18
   - Expected employment growth by occupation 22
   - Expected employment growth by major industry division 23
   - Job openings 26
   - Implications of employment projections 26

Charts:

1. Employment in computer occupations, 1970, 1980, and projected 1990 2
2. Employment of computer workers by industry division, 1970 and 1978 5
3. Percent change in employment of computer workers and all workers by industry division, 1970-78 6
4. Percent change in employment of computer workers by occupation, 1970-80 8
5. Distribution of computer workers by occupation, 1970 and 1980 9
6. Number of college programs in the computer sciences by degree level, 1966-67, 1973-74, and 1978-79 16
7. Number of bachelor's, master's, and doctoral degrees in the computer sciences, 1970-71 through 1978-79 17
8. Employment of computer workers by occupation, 1970-80 and projected 1990 19
9. Value of computer systems produced by U.S. manufacturers by type of computer, 1974-78 and projected 1979-83 21

Tables:

1. Description of duties of computer workers 4
2. Employment in computer occupations, 1970-80 4
3. Enlisted strength in Department of Defense computer specialties, 1971-79 13
4. Number of college degrees conferred in the computer sciences by degree level and curriculum, 1970-71 through 1978-79 14
5. Associate degrees conferred in data processing technologies, 1971-72 through 1978-79 15
6. Total enrollments and completions in public and private vocational programs, 1977-78 15
7. Employment in computer occupations, 1980 and 1990 22

Contents—Continued

Page

8. Employment in computer occupations by industry division, 1978 and projected 1990 24
9. Projected average annual job openings in computer occupations, 1980-90 26

Appendixes:

A. Methods 27
B. Industry distribution of computer employment by occupation, 1970, 1980, and projected 1990 29
C. Census occupational titles 39
D. Glossary of computer terms 40

Highlights

The use of computers has become widespread in our society.

- The number of computer systems has risen dramatically in the last decade. In 1980, more than 600,000 computer systems were in use, compared with only about 100,000 in 1970. The number is expected to continue to increase rapidly through the 1980's.
- At first limited to only a few industry applications, computers are now used in many industries. New applications are expected in the years ahead as rapid access to information becomes increasingly important.

The computer occupations are expected to be the most rapidly growing in the economy over the next decade.

- Employment in computer occupations is expected to rise from 1,455,000 in 1980 to 2,140,000 in 1990, an increase of 47 percent (chart 1). This is nearly three times as fast as the expected rate of growth for all occupations in the economy.
- Systems analysts are expected to increase from 243,000 to 400,000, or by 65 percent.
- Programmers are expected to increase from 341,000 to 500,000, or by 47 percent.
- Computer and peripheral equipment operators are expected to increase from 522,000 to 850,000, or by 63 percent.
- Keypunch operators are expected to decline from 266,000 to 230,000, a decrease of 14 percent.
- Computer service technicians are expected to increase from 83,000 to 160,000, or by 93 percent.

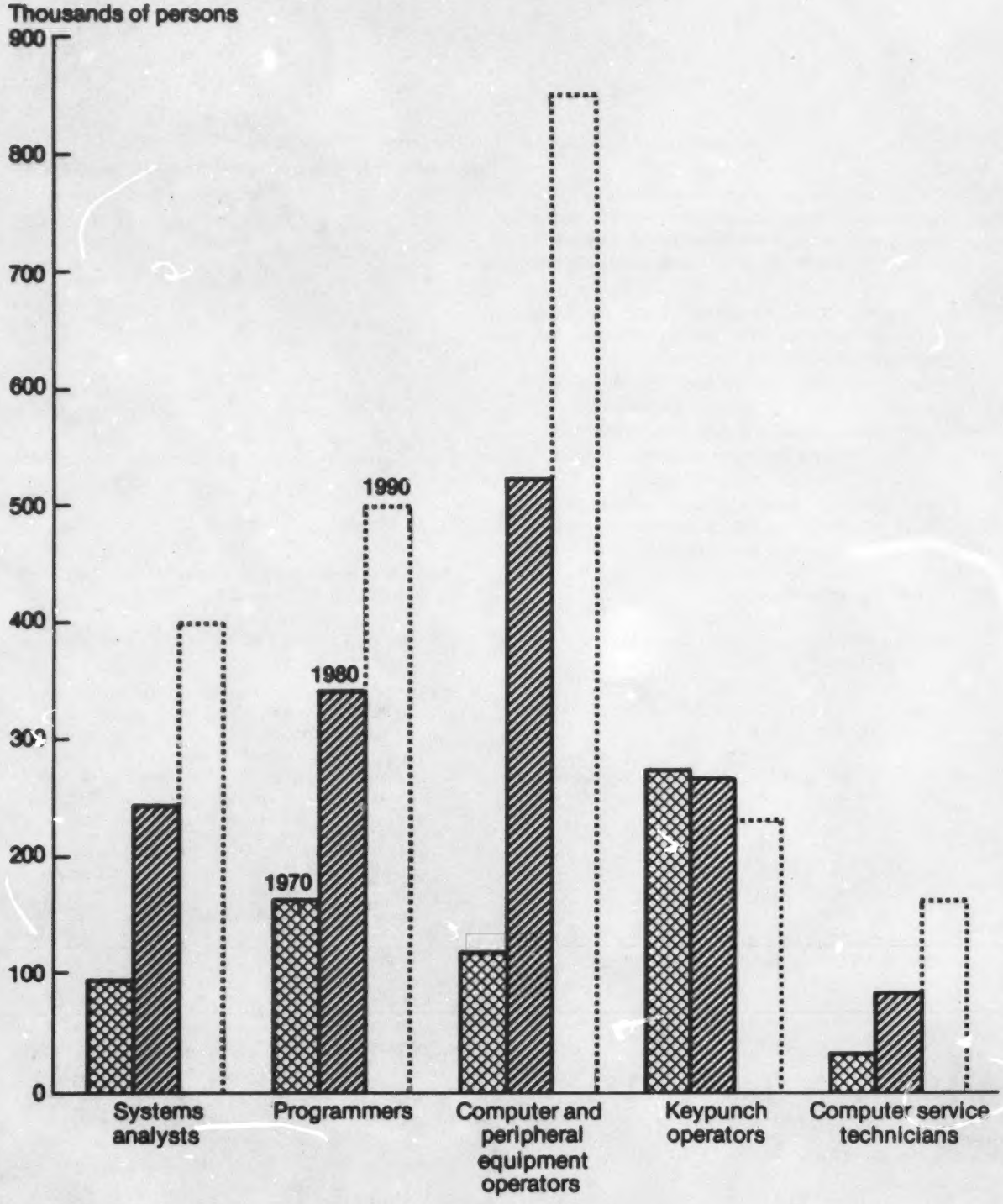
The increasing sophistication and complexity of computer operations will require workers with more and better training.

- Education and training for computer occupations have not kept up with needs.
- If future needs for trained computer personnel are to be met, major improvements are required in at least two areas— attracting qualified teachers and standardizing program content.
- Despite current shortcomings in education and training, improvements have been made. The number of computer degree programs is increasing rapidly, and there is a strong trend toward infusing computer training into curricula besides computer science.

Advances in all major areas of computer technology will supply the user with more computer capability per investment dollar.

- Hardware—Advances in microprocessor technology have stimulated the development of smaller, more efficient, and less costly computer equipment. Newer hardware is expected to have a significant impact on computer employment.
- Software—The development of easier-to-use programming languages and packaged programs is expected to continue. These developments, along with the trend toward incorporating systems programming functions into hardware, will permit more direct interaction between the user and the computer, and in some cases may simplify programmer job duties.
- Applications—The number of applications made practical by hardware and software advances will make the computer accessible to more users. This increased use due to new applications will be the most significant factor causing rapid growth in computer employment over the next decade.

Chart 1. Employment in computer occupations, 1970, 1980, and projected 1990



Source: Bureau of Labor Statistics.

Chapter 1. Employment

This study discusses employment in five computer occupations: Systems analysts, programmers, computer and peripheral equipment operators, keypunch operators, and computer service technicians.[1] Although a wide variety of other workers, from engineers to sales clerks, routinely use the computer in their daily tasks, this report focuses only on those occupations whose very existence depends on computers. Table 1 presents a brief description of the major job duties for each of the occupations studied.

In 1980, 1,455,000 persons worked in computer occupations. Two out of five worked with computer software, either in systems analysis or programming. Nearly 1 in 5 entered data as a keypunch operator while 1 in 20 maintained and repaired computer hardware. By far the largest single occupation was computer and peripheral equipment operator, which accounted for more than 1 of every 3 computer workers in 1980 (table 2).

Geographic distribution

Employment in computer occupations is concentrated in the major urban centers where the majority of companies owning general-purpose computer systems are located. The 25 metropolitan areas with the largest concentrations of general-purpose computers accounted for about 56 percent of the total value of these systems in 1978, and the top 100 metropolitan areas constituted 84 percent of this total.

However, as the use of minicomputers increases and as distributed data processing (DDP) networks become more widespread, computer systems will become less concentrated. This trend is expected to result in increased opportunities for computer employment outside metropolitan areas.

[1] Fifty-five different occupational titles, shown in appendix C, were subsumed by the Bureau of the Census in the 1970 Census and in the Current Population Survey from 1971 to 1980 under six occupational categories: Computer programmer, computer systems analyst, computer specialist not elsewhere classified, computer and peripheral equipment operator, keypunch operator, and data processing machine repairer. The BLS 1970 industry-occupational matrix paralleled the Census classifications. This study, however, combines two of these classifications, systems analyst and computer specialist not elsewhere classified, because of the similiarity of the work. This study also uses the term "computer service technician" in place of the Census title "data processing machine repairer" in order to better reflect the job duties these workers perform.

Industries of concentration

Although computer workers are found throughout the economy, 8 of every 10 are in four major industry divisions (chart 2).[2] In 1978, the greatest concentration, about 30 percent, was in the services division—primarily in computer programming services, colleges and universities, and accounting and auditing services. The second largest concentration, about 28 percent, was in manufacturing, predominantly in firms manufacturing durable goods. About 13 percent of all computer workers were in finance, insurance, and real estate, the great majority of whom worked in banks and insurance companies—organizations that have become heavily computerized in order to handle the large volume of transactions. Another 12 percent of all persons in computer occupations worked in wholesale and retail trade establishments. Most of these were concentrated in wholesale trade, where firms generally are large and where computers have been used for years for inventory and distribution functions.

The remaining five major industry divisions accounted for less than 20 percent of computer employment in 1978. Transportation, communications, public utilities, and government employed most of these workers; only 2 percent of all computer workers were found in mining, construction, or agriculture, forestry, and fisheries.

Industry trends, 1970-78

Employment of computer workers increased dramatically over the 1970-78 period, about two and one-half times as fast as the rate of growth of employment for the economy as a whole (chart 3). Computer employment grew rapidly in all industries, even in those that experienced little or no overall employment growth in the 1970's. In manufacturing, for example, total employment rose only 5 percent between 1970 and 1978, but computer employment rose 34 percent.

The growth of computer occupations is unlike the usual pattern of occupational growth whereby employment increases as a result of growth in the industries in which the occupations are concentrated. Employment of secretaries, for example, has grown rapidly in recent years, due in large part to the rapid growth of the

[2] Data on the industry division of computer workers are based on the 1978 industry-occupational matrix, the most current matrix available when this study was prepared.

Table 1. Description of duties of computer workers

Occupation	Duties
Systems analysts	Analyze business, scientific, and engineering problems for application to electronic data processing systems. These workers are classified according to their specialty. *In business,* they analyze business procedures and problems such as development of integrated production, inventory control, and cost analysis systems, to refine data and convert them to programmable form for electronic data processing. *In scientific and technical areas,* they perform logical analyses of scientific, engineering, and other technical problems, and formulate mathematical models of these problems for computer solution. *Systems engineers* analyze electronic data processing projects to determine equipment requirements. After determining equipment requirements, they may plan the layout and implementation of computer systems to achieve efficient operation.
Computer programmers	Convert business, scientific, and engineering problems to logical flow charts for coding into computer language. These workers are classified according to their specialty. They analyze all or part of a workflow chart or diagram to develop a sequence of program steps. To do this, programmers must apply their knowledge of computer capabilities, subject matter, mathematics, and symbolic logic. They then convert the steps to language that can be processed by the computer.
Computer and peripheral equipment operators	*Computer (console) operators* monitor and operate the control console of a computer to process data according to operating instructions. They set control switches on the equipment, select and load the input and output units with materials—such as tapes and printout forms—and then clear the system and start the equipment. During the run, they observe the machines and control panel for error signals. *Peripheral equipment operators* operate on-line or off-line peripheral machines, according to instructions, to transfer data from one form to another, print output, and read data into and out of the computer.
Keypunch operators	Operate alphabetic and numeric keypunch machines to transcribe data from source material onto punchcards, paper or magnetic tape, or cards.
Computer service technicians	Install, repair, and periodically service computer equipment, following blueprints and manufacturers' specifications. These workers test faulty equipment and apply their knowledge of electronics to diagnose defects. They replace or repair defective components. On occasion, they consult with customers when planning the layout for installation or in diagnosing system malfunctions.

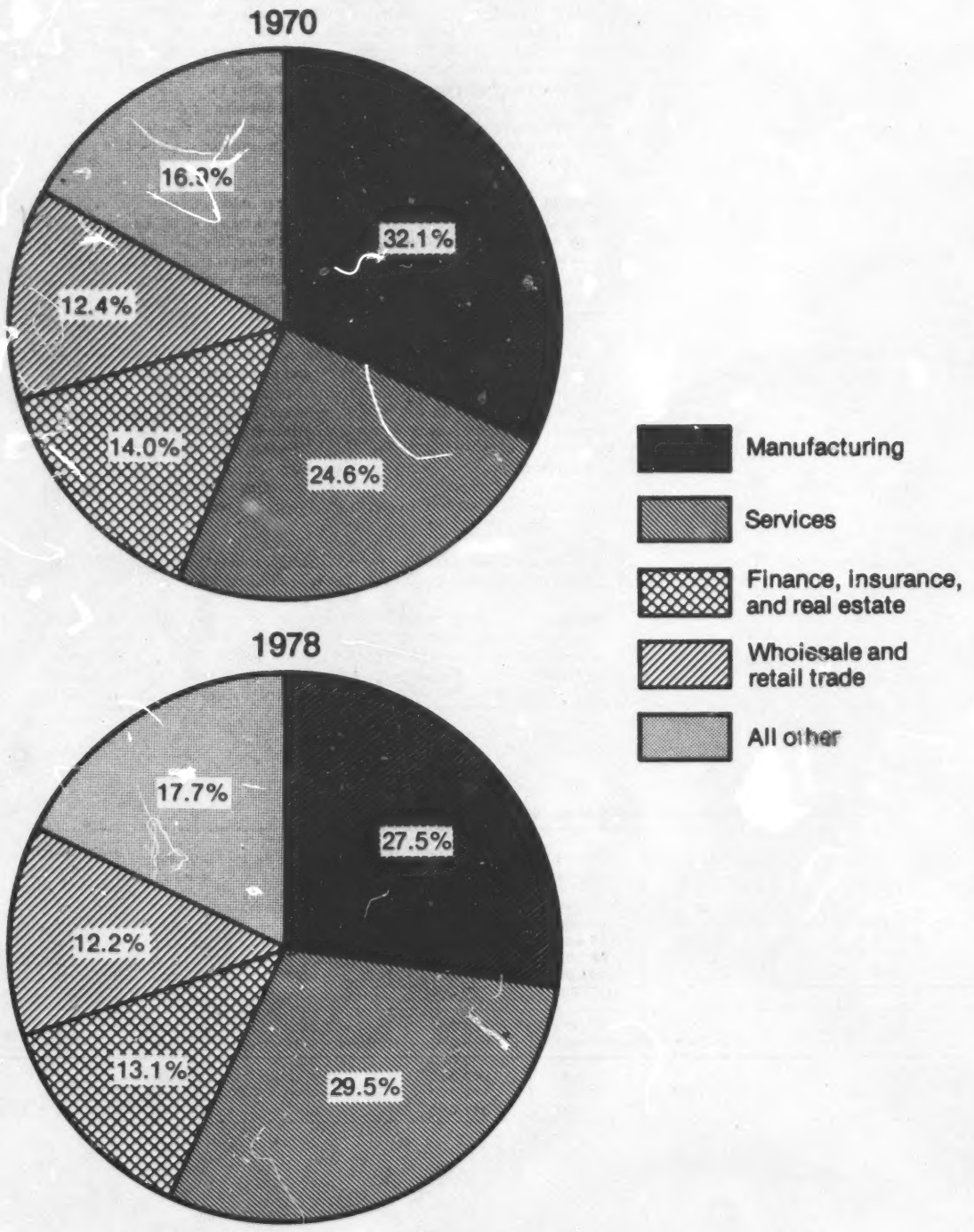
Source: Bureau of Labor Statistics.

Table 2. Employment in computer occupations, 1970-80

Year	Total	Systems analysts	Programmers	Computer and peripheral equipment operators	Keypunch operators	Computer service technicians
1970	676,037	93,200	161,337	117,222	272,570	31,708
1971	709,000	75,000	158,000	156,000	290,000	30,000
1972	796,000	88,000	186,000	196,000	283,000	45,000
1973	803,000	100,000	187,000	216,000	253,000	47,000
1974	867,000	113,000	199,000	246,000	249,000	50,000
1975	965,000	140,000	223,000	295,000	250,000	57,000
1976	1,000,000	158,000	229,000	287,000	276,000	50,000
1977	1,003,000	150,000	221,000	302,000	280,000	50,000
1978	1,158,000	182,000	247,000	393,000	273,000	53,000
1979	1,362,000	213,000	321,000	453,000	274,000	91,000
1980	1,455,000	243,000	341,000	522,000	266,000	83,000

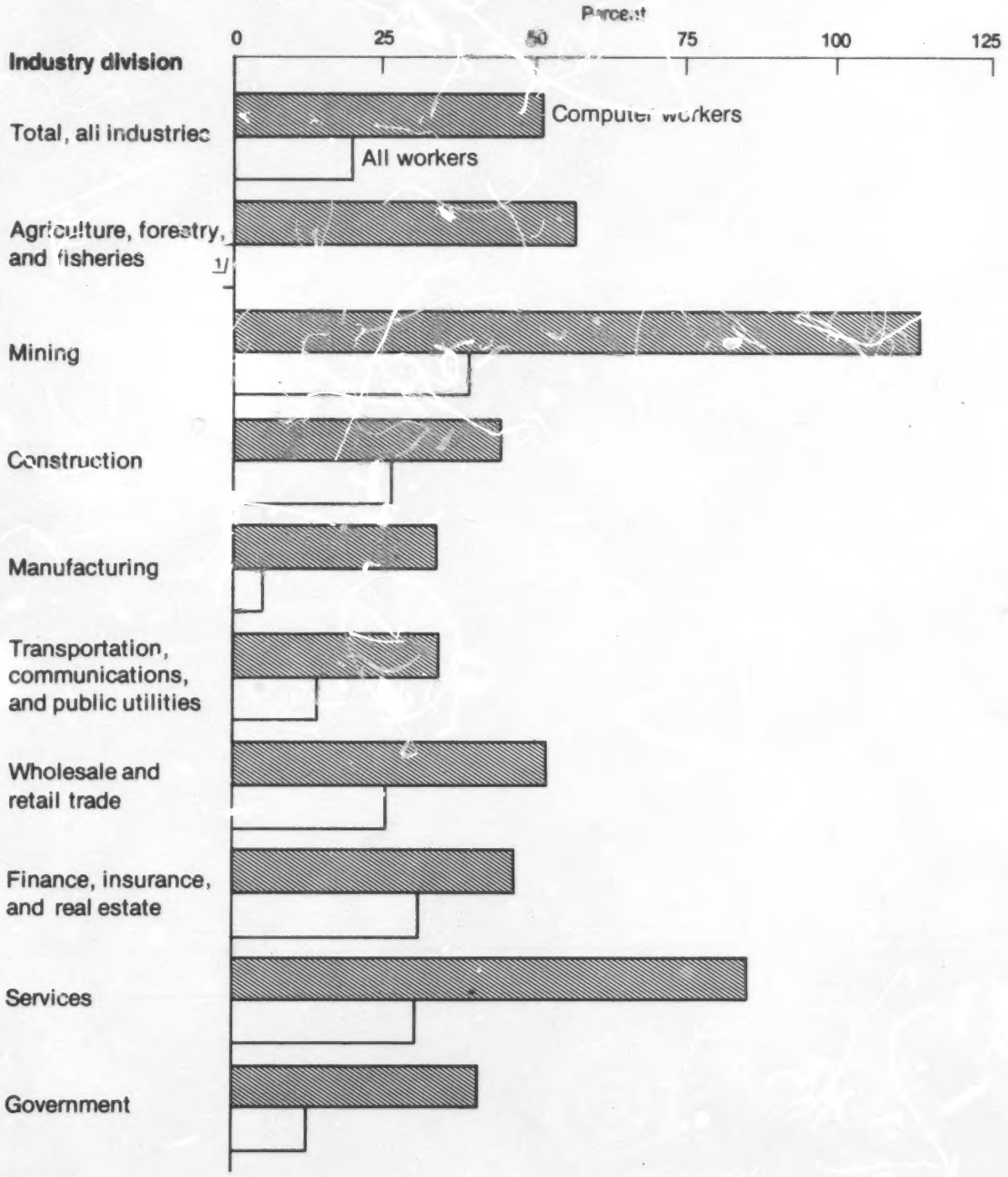
SOURCE: Bureau of Labor Statistics.

Chart 2. Employment of computer workers by industry division, 1970 and 1978



Source: Bureau of Labor Statistics.

Chart 3. Percent change in employment of computer workers and all workers by industry division, 1970-78



1/ Decrease of less than 0.05 percent.

Source: Bureau of Labor Statistics.

11

finance, insurance, and real estate sector and the services sector, which together employ almost one-half of all secretaries. As output of firms in these sectors expanded, more secretaries were needed to handle the greater number of support functions. Employment of computer workers, however, reflects an industry's capital expenditures for technology as employers install computers to increase efficiency and productivity, whether or not their output is expanding.

Not all industry sectors have computerized their operations at the same pace. These investment decisions are based on price and the adaptability of computer hardware and software to the needs of potential users. Prior to 1970, computers were generally limited to organizations whose size would justify the cost of a central mainframe. Many manufacturing firms, banks and insurance companies, wholesalers and large retailers, and colleges and universities maintained their own computer for batch processing of personnel records, payroll, inventory, and records of student enrollment, to list just a few standard applications. In addition, process control computers were applied to industrial processes that already had a high degree of control, such as steelmaking, petroleum refining, chemical production, and electric power generation. Organizations that could not afford to operate their own computer systems contracted with computer services firms to meet their data processing needs. Many others stayed completely out of the computer market.

Technological advances during the 1970's presented potential users with an array of more efficient and more flexible hardware and software at steadily falling prices that made it cost effective for a growing number of organizations to install a computer. More affordable mainframes, highly efficient minicomputers, small business computers, and a greater variety of software packages all contributed to the explosion in computer employment during the 1970's.

As previously noted, employment of computer workers in manufacturing firms grew almost seven times as fast as overall industry employment as smaller manufacturers installed less expensive mainframes and many others adapted computers directly to the production process. One technique that developed over the period was the utilization of minicomputers in distributed data processing networks throughout a plant to enable workers to better control operations such as the flow of raw materials and the precision measurement of manufactured items.

Computer employment in the services sector grew almost three times as fast as total industry employment as computer equipment became more affordable. Employment of computer workers grew rapidly in the types of establishments that already were computerized by the beginning of the decade—colleges and universities as well as firms providing accounting, auditing, and computer programming services. Even more rapid employment growth occurred in hospitals and other health services and in miscellaneous business services. Computer employment in health services increased as more flexible computer systems were increasingly adapted to medical diagnosis and patient care. Firms providing business management services, those doing commercial research and development, and private employment agencies were three of the more significant sources of growth in computer employment during the 1970's. These and other types of relatively small service firms were able to successfully incorporate small business computers into their operation.

Computer employment in wholesale and retail trade grew more than twice as fast as total industry employment as wholesalers installed distributed data processing networks to give themselves better control over their inventory and distribution functions. Employment in retail firms increased even faster as single-store operations installed a small business computer to handle their inventory and other business records and retail chains installed point-of-sale terminals linked to a central computer. Finance, insurance, and real estate experienced relatively moderate gains in computer employment between 1970 and 1978. This reflected the relatively slow growth of the insurance industry, which accounts for about one-third of total employment in this industry division, and the fact that operations in the insurance industry already had been largely computerized prior to 1970. This left only modest gains to be made in the 1970's.

Computer employment in government grew more than twice as fast as total government employment throughout the 1970's. This reflected the slower than average growth in government during this period, and the increasing use of computers to manage the enormous amount of recordkeeping that government programs require. Growth of computer occupations was strongest in State and local governments, where government employment growth was concentrated.

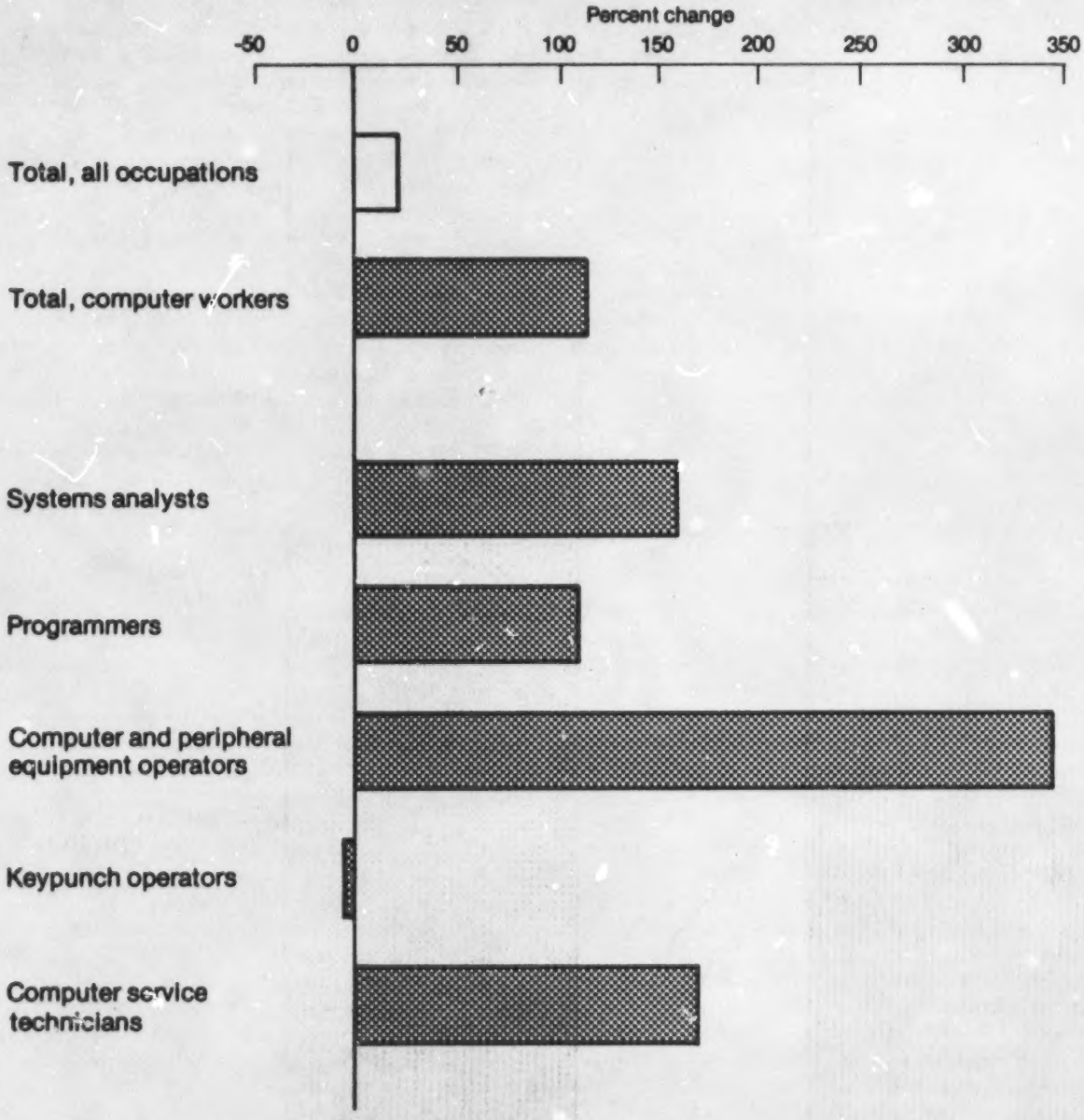
The smallest increase in computer employment occurred in transportation, communications, and public utilities. These are large, centralized industries that could afford the larger, more expensive computer systems available prior to 1970. It should be noted, however, that even this relatively modest increase exceeded the average growth rate for all occupations.

Computer employment in agriculture, forestry, and fisheries; mining; and construction combined increased faster than in any other sectors as the relatively small firms in these industries made substantial use of smaller, less expensive computer systems.

Occupational trends, 1970-80

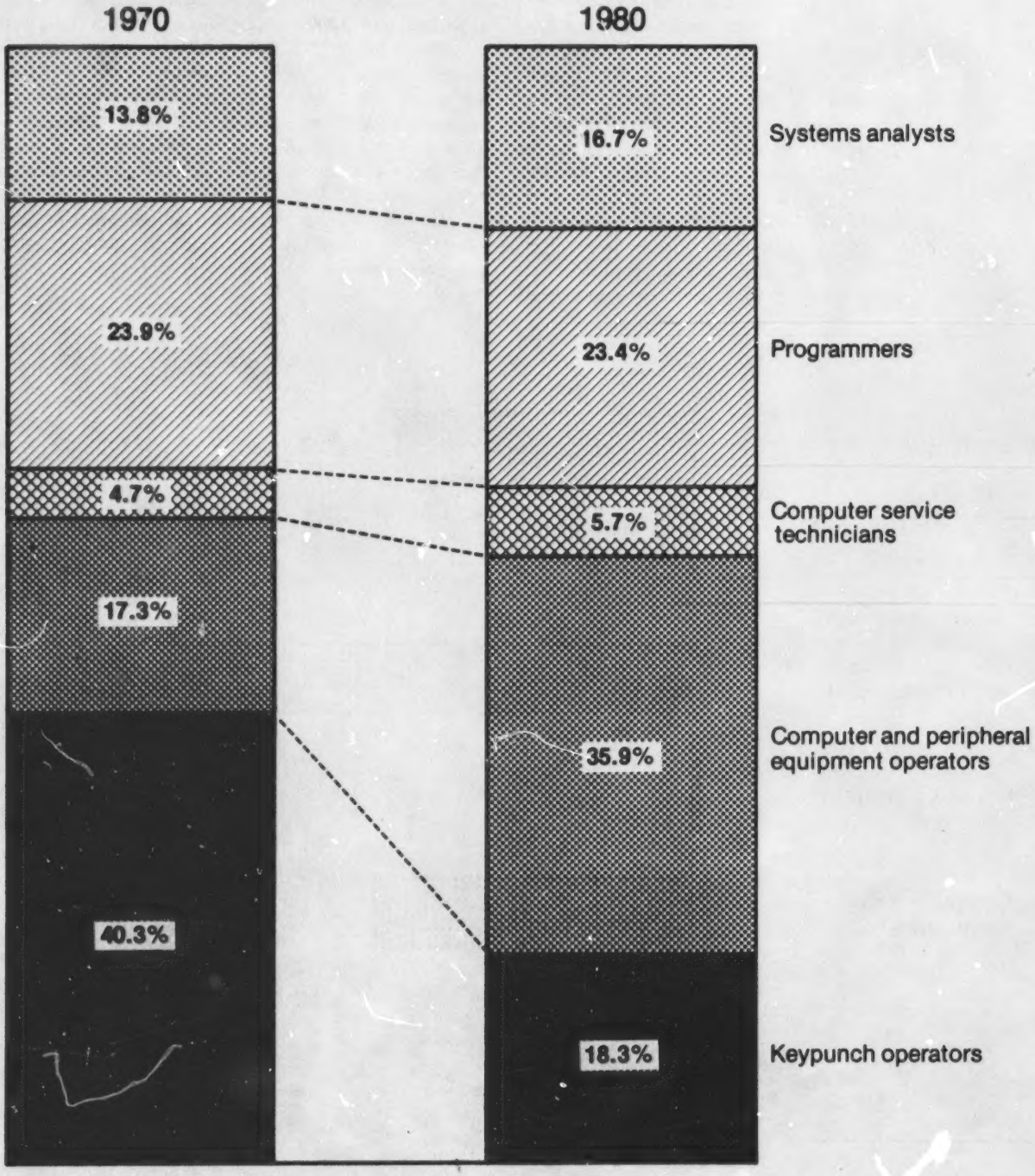
Employment of computer workers more than doubled between 1970 and 1980, growing from 676,000 in

Chart 4. Percent change in employment of computer workers by occupation, 1970-80



Source: Bureau of Labor Statistics.

Chart 5. Distribution of computer workers by occupation, 1970 and 1980



Source: Bureau of Labor Statistics.

1970 to 1,455,000 in 1980. This was nearly five times the average rate of growth for all occupations in the economy.

Technological advances and changes in methods of operation have resulted in vastly different rates of growth among the individual computer occupations (chart 4). All of the computer occupations except keypunch operators grew much faster than the average for all occupations. Programmer employment, for example, increased by about 111 percent, and employment of systems analysts increased by 161 percent, as industries in all sectors sought to develop and refine software for an increasing number of applications. Decreasing hardware costs and the resultant rise in the amount of computer equipment in use contributed to a 162-percent increase in the number of computer service technicians. The largest increase, however, was for computer and peripheral equipment operators, whose employment grew three and one-half times in response to the rapid increase in the number of computer systems in use. Employment of keypunch operators declined 2 percent as more efficient forms of data entry were developed.

The differing rates of growth experienced by the individual computer occupations signficantly changed the distribution of computer employment by 1980 (chart 5). Keypunch operator, for example, was the largest computer occupation in 1970, with about two-fifths of total computer employment. As technological innovations made their functions less important, their proportion of employment fell to less than one-fifth in 1980. By contrast, computer and peripheral equipment operators—who constituted less than one-fifth of computer employment in 1970—grew to become the largest of these occupations in 1980, representing over one-third of all computer personnel.

Chapter 2. Education and Training

Current requirements

Educational requirements for computer workers range from high school to a college degree and beyond. The most professional computer work, which involves systems design and analysis and systems programming, generally is done by persons having 4 years or more of college training. The middle range of computer work, involving scientific and complex business applications programming as well as equipment maintenance, is typically performed by those with training from a 2- or 4-year college or from a program operated by a computer vendor. The work requiring the least formal education involves basic applications programming, equipment operation, and keying functions. This work is usually carried out by high school graduates, many of whom have received some formal training from a public or private school or on-the-job training from a computer manufacturer or other source.

Regardless of educational level, however, the most desirable qualifications for programming and systems personnel are a background in computer science and data-processing-related subjects and a knowledge of the business the computer operation is serving. Educational requirements for the individual computer occupations are as follows:

Systems analysts. A bachelor's degree—including courses in computer science—generally is the minimum educational requirement. However, the type of degree employers prefer depends on the type of work done in the organization. For a job with a bank, insurance company, or business firm, a college degree in accounting, business, economics, or information systems is appropriate. For work in a scientific or technical organization, applicants need a degree in the physical sciences, mathematics, engineering, or computer science. In addition to the bachelor's degree in a suitable field, some employers prefer applicants to have related work experience.

Some employers require systems analysts to have a graduate degree. A growing number of employers seek applicants who have a degree in computer science or information systems. Regardless of college major, most employers look for people who are familiar with programming languages. Courses in computer concepts, systems analysis, and data base management systems offer good preparation for a job in this field.

In addition, most employers prefer applicants who have some experience in computer programming. Because of the importance of programming experience, many who begin as programmers are promoted to analyst trainees. Employers, computer manufacturers, and colleges and universities offer formal training in systems analysis.

Because technological advances occur so rapidly in the computer field, continuous study is required to keep skills up to date. Usually employers and "software" vendors offer 1- and 2-week courses. Additional training may come from professional development seminars offered by professional computing societies.

An indication of experience and professional competence is the Certificate in Data Processing (CDP), conferred by the Institute for Certification of Computer Professionals upon candidates who have completed 5 years' experience and passed a 5-part examination.

Programmers. There are no universal training requirements for programmers because employers' needs vary. Most programmers are college graduates; others have taken courses in programming to supplement their experience. Firms that use computers for scientific or engineering applications usually require programmers to have a bachelor's degree with a major in computer science and a minor in a physical science. Some of these jobs require a graduate degree. Although some employers who use computers for business applications do not require a college degree, they prefer applicants who have had courses in data processing, accounting, and business administration.

Public and private vocational schools, community and junior colleges, and universities teach computer programming and data processing. Instruction ranges from introductory courses to advanced courses at the graduate level. High schools in many parts of the country also offer courses in computer programming.

An indication of experience and professional competence at the senior programmer level is the Certificate in Computer Programming (CCP), conferred by the Institute for Certification of Computer Professionals upon candidates who have passed a 5-part examination.

Computer service technicians. Employers usually re-

quire applicants to have 1 to 2 years of post-high school training in basic electronics or electrical engineering from a computer school, technical institute, junior college, or 4-year college. A few technicians are trained through apprenticeship programs. Electronics training in the Armed Forces also is excellent preparation. Generally, 6 months to 2 years of on-the-job experience are required before newly hired technicians are considered competent to work independently on more complex systems. High school courses in mathematics, chemistry, and physics are considered good preparation. Communication skills also are important.

Computer operating personnel. High school graduation is the minimum educational requirement for computer operating jobs such as keypunch operator, auxiliary equipment operator, and console operator. Many employers prefer console operators who have some community or junior college education. Beginners usually are trained on the job; the length of training varies. Auxiliary equipment operators can learn their jobs in a few weeks, but console operators require several months of training before they are sufficiently familiar with the equipment to be able to trace the causes of breakdowns.

Formal computer training is desirable because most employers look for applicants who already are skilled in operating data entry equipment or computer consoles. High schools, vocational schools, computer and business schools, and community and junior colleges offer this type of computer training. Computer vendors also offer structured training programs for many of these workers.

Post-employment training

With the rapid changes in computer equipment and technology, there is a great need for continuing education programs for computer personnel. The extent of job-related supplementary training varies widely. Some employers have regularly scheduled, in-depth training programs in areas such as computer languages or data processing operations. Others provide this type of training only when changes are made in computer procedures or equipment. Many companies also maintain a tuition refund plan or pay for employee attendance at professional seminars. Regardless of the type or length of training, it is usually paid for by the employer.

The most common types of supplementary training include computer vendors' course offerings, in-house training programs, on-the-job training, professional seminars, and reimbursement for college, correspondence, and vocational school courses. The length of post-employment training ranges from a few hours to more than 1 year, but training usually is completed in 1 to 12 weeks—with the higher level computer jobs generally requiring the more lengthy training.

Among computer occupations, systems analysts most frequently take computer science courses as well as systems, programming, and management training. Programmers usually train in programming languages and techniques and, to a lesser extent, in systems analysis and design. Training for computer service technicians often involves computer electronics and related courses. Console, peripheral equipment, and keypunch operators train in data preparation, production control, computer equipment operation techniques and, occasionally, programming.

Current status of education and training

As described in the previous sections, various types of computer education and training currently are available. Because of the relative newness of the computer occupations and the shortage of skilled computer workers, however, some problems exist in training computer personnel.

One major problem that has persisted from the beginning of the computer era is a shortage of qualified teachers in this field. Educational institutions find it very difficult to keep their experienced teachers or to attract qualified teachers because salaries and research facilities often are not comparable with those offered by private industry. Many institutions are unable to offer more computer science courses because there are not enough instructors.

As a result of the shortage of qualified teachers and programs, the number of people receiving college degrees in computer science, although rising rapidly, is falling short of employers' needs. Graduates of programs in computer science are only filling 1 out of 4 jobs at the bachelor's level, 1 out of 10 jobs at the master's level, and 1 out of 4 jobs at the doctorate level.[3]

Due to the unique nature of the computer field—technological advances and applications are increasing at a very rapid rate—educational institutions find it difficult to design and implement courses that disseminate the latest developments in a timely manner. Thus, the subject matter in similar course offerings from different schools is not always consistent.

Despite the shortcomings of computer education and training in its current form, a number of positive developments have occurred in the past few years.

One development in computer education is the trend toward infusing computer training at the college and university level into other curricula besides computer science. For example, most schools now offer computer courses in their business and engineering programs. Furthermore, one college administrator has estimated that 1 out of 3 undergraduates and 1 out of 2 graduates now use a computer in their coursework.

In order to make programs more relevant and to

[3] John W. Hamblen, *Computer Manpower—Supply and Demand—by States, 1981* (Information Systems Consultants).

encourage consistency among computer curricula, the Association for Computing Machinery has issued revised recommendations for computer education programs. These guidelines include detailed course descriptions as well as recommendations on program organization and implementation.

Steps also have been taken by colleges and universities to meet the needs of those already in the labor force. Many schools now offer night courses in computer science, most of which are tailored to meet specific job requirements.

Computer vendors and others have refined their "canned" learning programs to meet employers' needs. These courses now cover a variety of computer concepts and practical applications. The programs, which utilize a number of learning techniques, are especially useful for occupations with high turnover because they are self-paced and relatively inexpensive.

As the computer becomes more prevalent in all aspects of our economy, it is increasingly important for people to become familiar with this tool. Towards this end, a growing number of high schools are offering computer education courses. These provide the student with some programming knowledge as well as an understanding of the logic of computing, and are excellent preparation for use of the computer in any career.

In summary, educating and training enough computer personnel to meet employer's needs still present a number of problems. The relative newness of the field, its rapidly changing technology, and the inability of educational institutions to compete for skilled teachers have all been contributing factors to the shortage of qualified computer workers in computer occupations. For a better understanding of the current situation, a brief look at the evolution of computer education and training is provided below.

Evolution of education and training

The dramatic rise in computer use during the 1950's outstripped the availability of personnel with data processing skills. As opportunities in the computer field expanded rapidly and the demand for skilled computer workers increased, many people sought training in this field. But schools were not yet providing courses in data processing. The educational system, of course, required a certain amount of time to develop programs to meet the specific needs of employers. Additionally, the implementation of educational programs was delayed by two factors. First, computers were needed to provide practical experience for the student, and this equipment was prohibitively expensive during the 1950's. Secondly, the relatively few people who were qualified to teach at that time could earn considerably more money in the business world.

As equipment costs gradually declined and as more instructors became available through the 1950's and 1960's, a growing number of public and private colleges, universities, and vocational schools began to include data processing in their curriculums. Nevertheless, the number of graduates with specific training for computer jobs continued to fall further behind the rapidly growing demand. To fill this widening gap, a large number of private vocational schools were established that offered computer training. Some of these schools, however, were criticized for providing poorly qualified teachers, limited subject matter, and obsolete computing equipment.

Thus, the major sources of training in the 1950's and 1960's became the computer manufacturers. Many persons trained in this way acquired only limited skills because their training usually focused on the operating procedures for their company's computer system. Employees trained in this manner, therefore, found it difficult to transfer or advance to jobs requiring knowledge of different types of computers and related equipment.

Computer manufacturers continued to provide training as part of the overall computer sales package until the early 1970's. As a result of antitrust settlements, manufacturers thereafter considered training a separate service that required a separate charge. Thus, the growing awareness of computer education costs led many

Table 3. Enlisted strength in Department of Defense computer specialties, 1971-79

Year	Total, computer specialties	ADP repairers	ADP support and administration[1]
1971	31,780	9,168	22,612
1972	29,591	8,516	21,075
1973	28,326	8,525	19,801
1974	26,736	7,860	18,876
1975	26,238	8,184	18,054
1976	22,843	7,683	15,160
1977	20,760	7,284	13,476
1978	20,433	7,353	13,080
1979	20,509	7,419	13,090

1 Includes computer operators, analysts, programmers, and electric accounting machine operators.

SOURCE: U.S. Department of Defense, Defense Manpower Data Center.

computer users to look for and closely evaluate alternative training methods in order to get the most for their computer education dollar.

One alternative for computer users was to train their own computer personnel. These "in-house" training programs generally took place at the user's site and were tailored to meet the specific needs of the company's computer operations. The programs were usually administered by company personnel or an educational services firm, and included instructional tools such as videotapes, cassettes, and self-paced computer manuals.

Another source of training for computer personnel was the Armed Forces. Although occupation-specific data are not available for years prior to 1971, the Armed Forces are believed to have been a major source of computer training during the 1950's and 1960's. As may be seen in table 3, however, the number of military personnel in computer-related job specialties declined sharply over the 1970's.

Computer education and training continued to evolve throughout the decade. In addition to the growing number of in-house training programs, the number of formal degree programs offered by colleges and universities increased dramatically in response to rising student interest and to requests from employers for graduates with a higher level of specific computer skills. The number of computer and information science programs offered at every degree level more than doubled over the period 1966-67 to 1978-79 (chart 6). Bachelor's degree programs experienced the most spectacular growth—554 percent. Associate degree programs in the computer fields grew 225 percent for the period. Growth in master's and Ph.D. programs was not as rapid as at the undergraduate levels—reflecting the strong demand for computer workers and the rising wages—but the number of programs still increased 162 percent and 117 percent, respectively.

Along with the growth in degree programs, the number of persons receiving degrees in the computer sciences also increased sharply. From 1970-71 to 1977-78, the total number of bachelor's, master's, and doctoral degrees in these fields grew from 4,104 to 12,060—a 194-percent increase (chart 7). Historical data by degree level for six computer curricula are presented in table 4.

The number of associate degrees awarded in data processing technologies fluctuated considerably in the 1970's (table 5). The number of associate degrees in all data processing technologies fell over the first half of the decade, then increased steadily over the remainder

Table 4. Number of college degrees conferred in the computer sciences by degree level and curriculum, 1970-71 through 1978-79

Degree level and year	Total, computer and information sciences	Computer information sciences, general	Information sciences and systems	Data processing	Computer programming	Systems analysis	Computer and information sciences, other
Bachelor's:							
1970-71	2,388	1,624	177	409	32	88	58
1971-72	3,402	2,451	268	504	8	72	99
1972-73	4,304	3,278	234	566	14	97	115
1973-74	4,756	3,761	338	539	15	54	49
1974-75	5,033	4,127	308	410	5	138	45
1975-76	5,652	4,530	493	483	3	89	54
1976-77	6,407	5,229	553	466	20	105	35
1977-78	7,201	5,940	742	395	24	61	39
1978-79	8,769	7,350	840	442	56	48	33
Master's:							
1970-71	1,588	1,131	143	171	5	88	50
1971-72	1,977	1,572	142	131	7	110	15
1972-73	2,113	1,627	115	144	0	153	74
1973-74	2,276	1,801	198	113	8	124	32
1974-75	2,299	1,921	147	114	0	79	38
1975-76	2,603	2,349	166	1	0	87	0
1976-77	2,798	2,580	149	6	0	60	3
1977-78	3,038	2,713	234	53	0	30	8
1978-79	3,065	2,773	183	51	0	23	25
Doctorate:							
1970-71	128	110	11	0	0	6	1
1971-72	167	145	16	0	0	6	0
1972-73	196	165	17	0	0	0	14
1973-74	198	178	13	0	0	0	7
1974-75	213	196	17	0	0	0	0
1975-76	244	221	20	0	0	3	0
1976-77	216	195	20	0	0	1	0
1977-78	196	183	13	0	0	0	0
1978-79	236	227	9	0	0	0	0

SOURCE: U.S. Department of Education, National Center for Education Statistics.

of the decade. Only two courses, computer programming and data processing equipment maintenance, registered any net growth over this period. This reflects the higher training requirements for programmer trainees and computer service technician trainees—some formal training generally is required—than for console and peripheral equipmemt operators, keypunch operators, and related workers. The decline in the number of degrees in these latter areas reflects the ability of many jobseekers to take entry level positions without any formal training. Some of those who chose to take formal training may have opted for public or private vocational programs that generally can be completed in less time than an associate degree and at a lower cost.

Public and private vocational schools provide another source of training. Because historical data are not available, it is difficult to determine whether vocational schools are growing in importance as a source of trained computer workers. Nevertheless, over 235,000 students were enrolled in these schools in 1978, with 9 of 10 enrolled in public vocational education programs (table 6). The number of persons —58,000—who completed these programs in 1978 was about 6 times the number of associate degrees awarded that year, greatly expanding the pool of jobseekers with at least some formal training.

Table 5. Associate degrees conferred in data processing technologies, 1971-72 through 1978-79

Curriculum	HEGIS code[1]	Associate degrees awarded							
		1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79
Total, data processing technologies	5100	8,971	7,640	6,998	6,821	7,176	7,993	9,339	10,833
Data processing technology, general	5101	5,669	4,584	4,360	3,921	3,981	4,671	5,095	5,974
Keypunch operator and other input preparation technology	5102	402	327	133	237	202	131	264	230
Computer programmer technology	5103	2,198	2,118	2,018	2,199	2,547	2,618	3,368	3,797
Computer operator and peripheral equipment operation technology	5104	431	249	205	240	229	304	263	475
Data processing equipment maintenance technology	5105	104	103	226	179	188	241	319	299
Other	5199	167	259	56	54	21	28	30	58

[1] HEGIS codes are from the Higher Education General Information Survey; see *A Taxonomy of Instructional Programs in Higher Education* (U.S. Department of Health, Education, and Welfare, 1970).

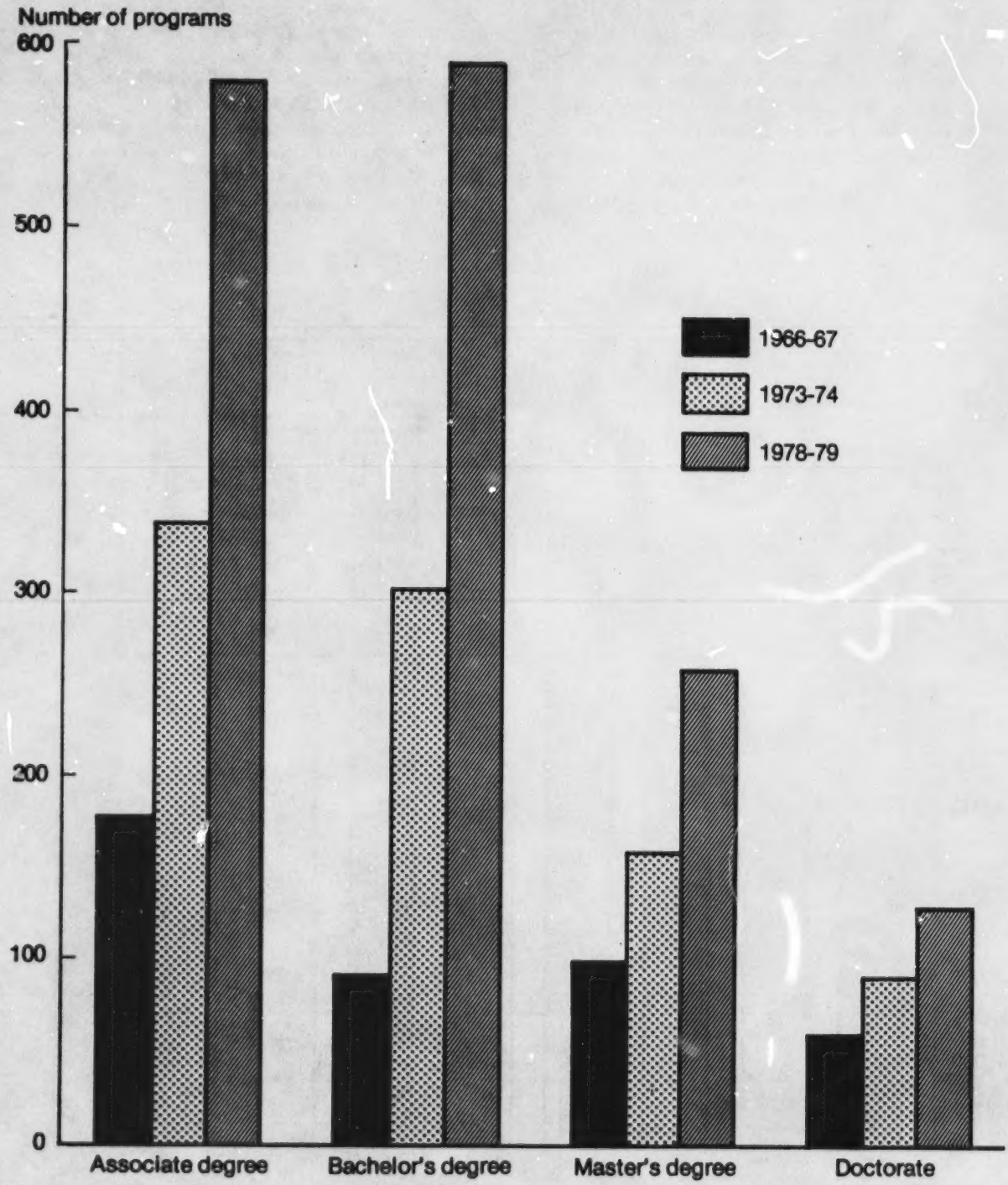
SOURCE: U.S. Department of Education, National Center for Education Statistics.

Table 6. Total enrollments and completions in public and private vocational programs, 1977-78

O.E. instructional code and title	Public vocational education		Private vocational education	
	Enrollments	Completions	Enrollments	Completions
Total	218,160	45,599	18,737	12,188
14.0201 Computer and console operator	50,666	11,519	785	627
14.0202 Keypunch operator	—	—	7,674	5,171
14.0203 Computer programmer	83,479	11,165	6,913	4,776
14.0299 Other business data processing	84,015	22,915	3,365	1,614

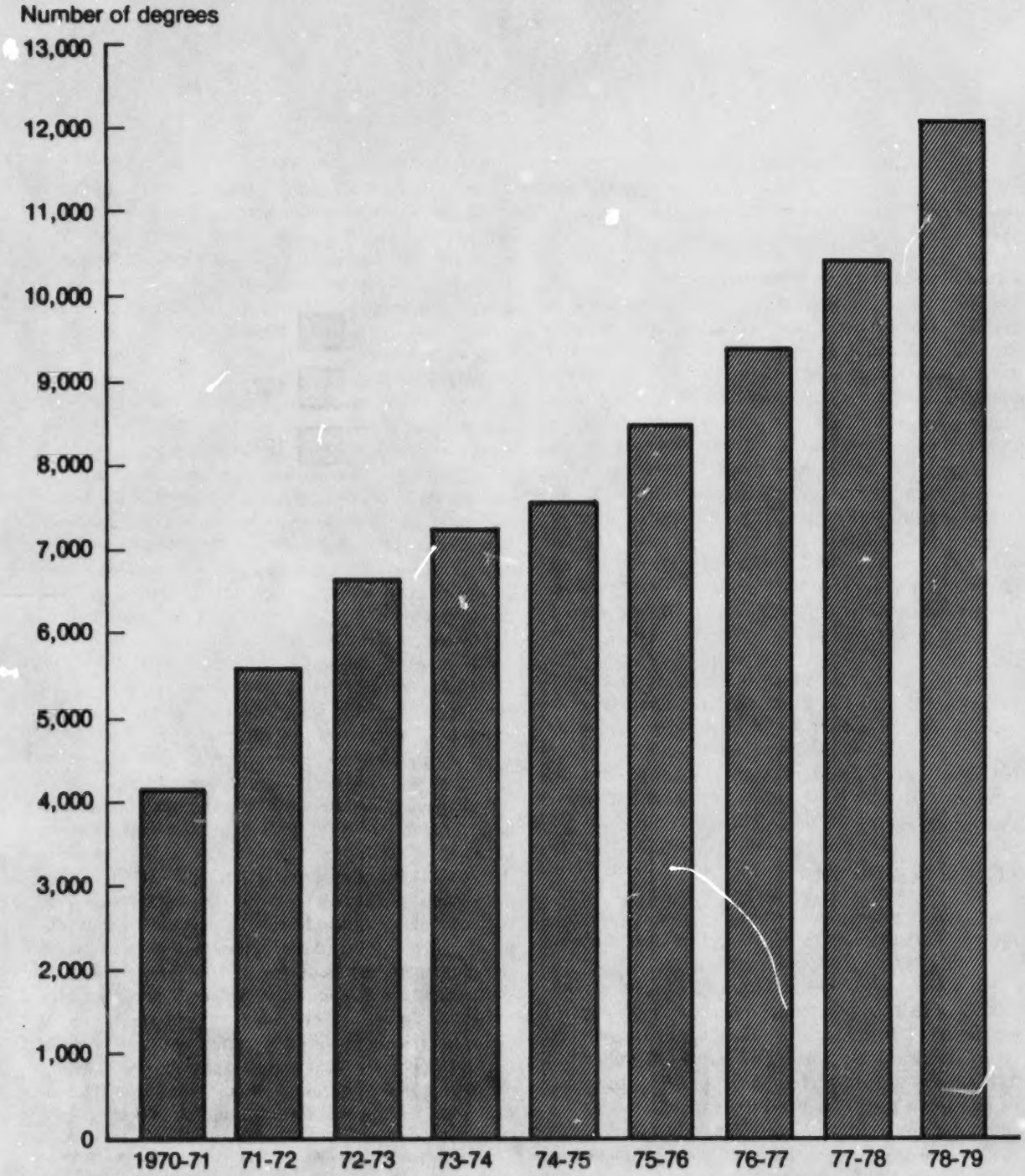
SOURCE: U.S. Department of Education, National Center for Education Statistics.

Chart 6. Number of college programs in the computer sciences by degree level, 1966-67, 1973-74, and 1978-79



Source: John W. Hamblen, *Computer Manpower—Supply and Demand—by States*, Table 1.

Chart 7. Number of bachelor's, master's, and doctoral degrees in the computer sciences, 1970-71 through 1978-79



Source: U.S. Department of Education, National Center for Education Statistics.

Chapter 3. Projected Employment Requirements

Even after the spectacular gains registered in the 1970's, overall employment in the computer occupations is expected to increase by nearly one-half from 1980 to 1990 (chart 8).

Technological factors affecting growth

Rapid technological progress is expected to continue over the next decade—affecting the types of computers available, computer applications, and the size and composition of computer occupations. New technologies that will affect employment can be divided into three major areas: Hardware (computer mainframe and peripheral equipment), software (computer programs and languages), and applications. These areas are all interrelated; advances in any one area generally have major implications for the others. The development of more efficient hardware, for example, can generate a whole spectrum of new applications. Elements in each of these three areas that are expected to have a significant impact on employment in the computer field are discussed in the following sections.

Hardware. Recent advances in semiconductor technology have spurred the development of computer components that are smaller in size but have greater memory and more available functions. In addition, prices have declined to the point where hardware costs are less than computer personnel costs in most data processing department budgets. These technological advances have led to new types of computer hardware as well as major improvements to existing hardware. Three major technologies that are expected to have a significant impact on computer employment are discussed in this section: Computer terminals, optical character recognition equipment, and minicomputers.

Improvements in the efficiency of computer terminals have resulted in a rising utilization of this type of equipment. The number of installed terminals is expected to increase from just over 2 million at the end of 1978 to almost 5 million by the end of 1983.[4] Terminals can be applied to many present computer systems, improving present applications or making possible new applications involving the transfer of data from one location to another for processing.

Among the computer occupations, increased terminal use will have its greatest impact on keypunch operators. Fewer of these workers will be needed, as data entry operations continue to move from card punch to more efficient on-line data entry systems. Airlines, for example, routinely use terminals at their ticket sales locations that are linked by data communications systems to a central computer. Data are entered directly into the central computer by reservation and ticket agents instead of keypunch operators who traditionally have worked at the central computer site. This example illustrates another important facet of computer terminal usage—terminals are expected to have a greater impact on noncomputer occupations than on computer occupations. As new applications are developed for terminals, more and more workers in noncomputer jobs will have to adapt to using terminals. Bank tellers and loan officers, for example, increasingly will operate terminals connected to the bank's central data base, and newspaper reporters and editors will use terminals in their work as well.

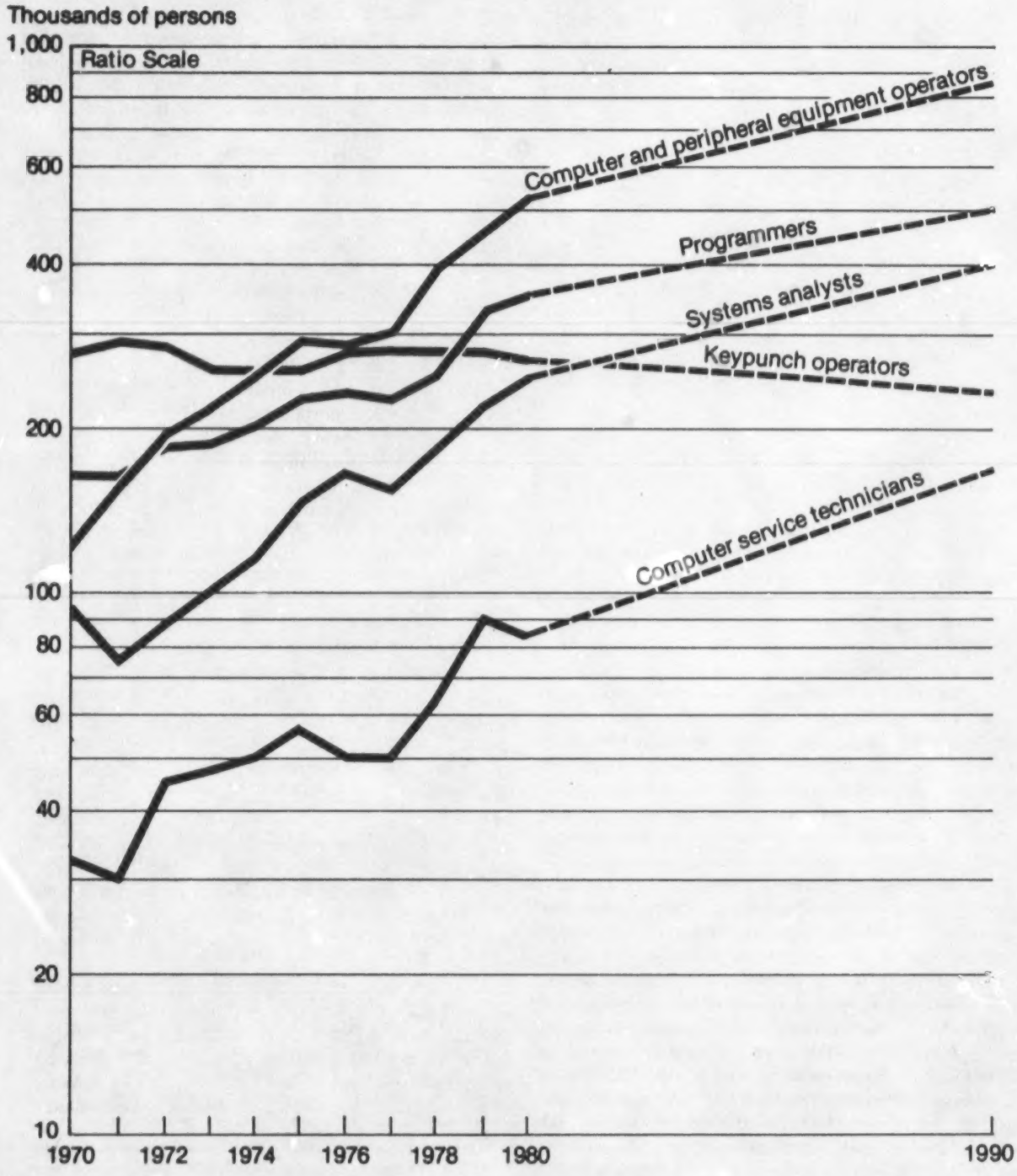
Optical character recognition equipment (OCR) provides another form of computer data entry. OCR equipment "reads" printed information in various forms and translates that information into computer input form. These machines can enter data into a computer system at a very high speed. This equipment, however, was slow in gaining acceptance due to its high cost and the limited number of typefaces it could recognize. Recent advances in microprocessor technology have reduced the cost of this equipment. Additionally, OCR equipment gained greater acceptance in the marketplace with the introduction of hand-held scanners, which have exposed more users to the accuracy and ease of use of this data entry technique.

Although applications for this equipment are still somewhat limited, an expanded product line that now includes three types of OCR equipment has contributed to the development and acceptance of a growing number of new applications. Each type of equipment, of course, has applications for which it is best suited.

- Page readers can identify characters at various locations on a sheet of paper. Page readers originally were used in the printing and publishing industries, but applications now have been developed for other businesses, such as insurance, where forms are sent in for processing to a

[4] International Data Corporation, *Special Report: Computer Industry Review and Forecast 1974-1983* (Waltham, Mass.).

Chart 8. Employment of computer workers by occupation, 1970-80 and projected 1990



Source: Bureau of Labor Statistics.

central location from points all over the country.

- Document readers can recognize a few lines of information on a single pass. The major application of document readers is for billing purposes. Major users include credit card companies and public utilities.
- Hand-held scanners, which are mainly used in department stores in conjunction with point-of-sale terminals, are passed over an item manually to pick up pricing and inventory information. Other users include libraries, where these scanners are used to check out books, and businesses, for inventory and production control.

Although not technically considered OCR equipment, other forms of character recognition equipment have gained increased acceptance in recent years.

- Bar code readers recognize printed vertical bars of varied sizes. This equipment is mainly used in grocery stores to read the Universal Product Code.
- Optical mark readers (OMR) detect the presence or absence of marks at specific locations on a document. Their most common application is in educational testing. Utilities also use this technique for reading meters.
- Magnetic ink character recognition equipment (MICR) senses characters printed in a magnetic ink. The best example is found in banks, which use MICR for check clearing.

In general, the widespread use of these character recognition technologies will not have a major effect on the overall employment of computer workers. The impact on keypunch operators, however, almost certainly will be negative as these data entry techniques increasingly replace card punching.

Minicomputers {(minis) are yet another rapidly growing technology in the computer field. The value of minicomputer shipments by U.S. manufacturers is expected to more than triple between 1978 and 1983—increasing from $3.1 billion to $10.3 billion (chart 9). These machines, once defined as inexpensive, single-purpose computers, now encompass a wide range of capabilities and functions.

Small businesses—relative newcomers to the computer market—will increasingly use minicomputers as hardware costs continue to decline and more applications are developed. Small businesses use minis for general applications such as personnel administration, inventory control, payroll, and general business planning, as well as for industry-specific applications such as optimizing fertilizer and other crop input requirements and projecting insect activity in agricultural production.

Large businesses, especially those with widely scattered field offices, such as insurance companies, also will utilize more minis—often in conjunction with their central computer. These distributed data processing systems give processing capabilities to data users who can immediately use the information. They permit data entry and manipulation by workers at different locations, thus increasing the efficiency and flexibility of field operations.

Increased minicomputer utilization will have employment implications for all the computer occupations. A greater amount of equipment in operation can be expected to spur demand for computer and peripheral equipment operators and computer service technicians. More systems analysts and programmers also will be needed to design systems using this equipment and to develop programs for the ever-increasing number of applications. Keypunch operator employment, however, will be negatively affected as minis increasingly are used for on-line data entry.

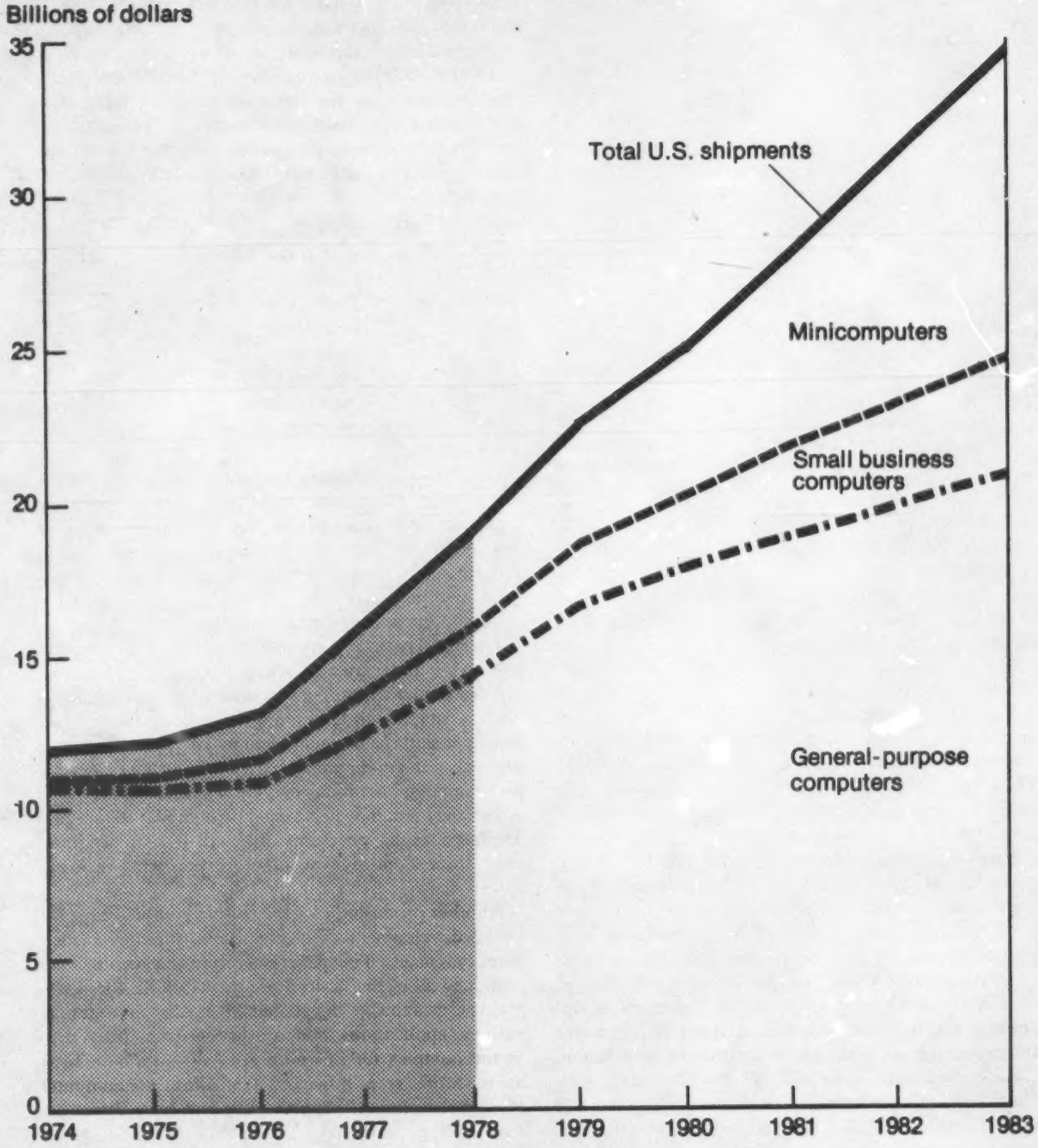
Software. Computer software will continue to evolve rapidly in a number of areas, resulting in increased productivity for many computer users. These software advances also will affect specific computer occupations, especially programmers and systems analysts. While there will be continued strong demand for these workers, their specific job duties may be affected. Software developments also will continue to make the computer more accessible to workers in such fields as publishing and medicine.

One trend in software technology has been the incorporation of systems programming functions into computer hardware. If this trend continues over the next decade, it may curb the demand for some systems programmers. Overall demand for programmers, however, will remain strong—allowing these workers to shift to other types of programming.

Packaged programs are another software option available to computer users. These programs, which are being developed for an ever-increasing number of applications, simplify programming operations, reduce programmer skill requirements, and may require fewer programmers at a computer site. In some instances, certain programming operations may be simplified to the point where they could be performed by computer operators. These packaged programs also will permit programming to be done by noncomputer personnel in many cases.

Another promising area for software improvement is in the development of user-oriented, high-level computer languages. Thus far, research in this area has not produced all of the desired results. COBOL, for example, was a language developed for use by managers in business applications, but in practice it has proved to be too complex for this purpose. Advances have been made in this area, however, that allow noncomputer personnel to bypass programmers and have direct access to the computer. Table Producing Language (TPL), for example, now allows noncomputer workers such as social scientists to use computers in their daily work. Improved hardware and further advances in

Chart 9. Value of computer systems produced by U.S. manufacturers by type of computer, 1974-78 and projected 1979-83



Source: International Data Corporation.

software technology may lead to the development of even more high-level languages.

Applications. Increases in the number of applications will be the main stimulus to computer employment growth over the next decade. Although progress in hardware and software technology may temper the demand for computer workers at some computer sites, these same technological advances are expected to bring the computer within reach of an increasing number of users.

Some new applications will be made possible with the continued development and refinement of new computer hardware. For example, computers can be applied to point-of-sale operations in supermarkets or department stores through the use of computer terminals, character recognition equipment, and other types of data communications equipment. Data communications networks also will permit traditional computer users to develop and implement new computer applications. Banks, for example, will increasingly use terminals for electronic funds transfer systems (EFTS).

Along with the introduction of new hardware, the cost of computer equipment has dropped dramatically in recent years. These reductions in hardware costs are expected to continue, allowing more relatively small organizations to utilize computers. These newcomers will use the computer for traditional functions, such as accounting and inventory control. Additonally, they will have new, industry-specific applications, creating more jobs for computer personnel over the next decade. Small oil and gas exploration firms, for example, are increasingly using computers for such specialized applications as production statistics, land lease data, and geologic and engineering applications.

New software developments, such as higher level, easy-to-use languages, will continue to make the computer more accessible. This will increase the number of potential computer users, especially small businesses. Also, more industries will become computerized as packaged programs are developed for their specific applications.

As may be seen from the above, hardware, software, and applications are all interrelated. While hardware and software developments may appear to curb the demand for some computer workers due to increased productivity, this is only a small part of the overall story. Far more important in terms of employment impact will be the expanding number of applications made practical by these hardware and software advances. As the computer is made accessible to more users through these developments, many more computer workers will be needed.

Expected employment growth by occupation

In general, a greater variety of applications, advancing software technology, and more efficient computer hardware all lead to a greater utilization of computer equipment, which will result in a growing demand for computer personnel over the next decade. Table 7 presents employment projections for each of the computer occupations. Increasing applications and greater amounts of hardware, for example, are expected to spur the employment of computer and peripheral equipment operators and computer service technicians. At the same time, changes in data entry methods will reduce the demand for keypunch operators. A summary of the employment outlook for each computer occupation follows.

Systems analysts. Employment of systems analysts is expected to increase from 243,000 in 1980 to 400,000 in 1990, or by 65 percent.

The history of computers has been marked by many unsuccessful attempts to solve problems, reduce costs, and increase productivity. A major cause of such failures has been the lack of adequate systems analysis and design to take full advantage of computer capabilities. As the requirements of computer users continue to escalate, they will demand greater efficiency and increased performance from their computer systems. Similarly, computer hardware and software advances will increase computer application possibilities and the compatibility of equipment from different sources. These advances also will permit "networking" or other equipment interrelationships, such as distributed data processing, in new and existing computer systems. As a result, systems analysts, who have always been in great demand, will continue to be sought to reduce computer systems

Table 7. Employment in computer occupations, 1980 and projected 1990

Occupation	1980 employment	Projected 1990 requirements	Percent change, 1980-90
Total, all occupations	1,455,000	2,140,000	47.1
Systems analysts	243,000	400,000	64.6
Programmers	341,000	500,000	46.6
Computer and peripheral equipment operators	522,000	850,000	62.8
Keypunch operators	266,000	230,000	−13.5
Computer service technicians	83,000	160,000	92.8

SOURCE: Bureau of Labor Statistics.

problems and develop more sophisticated and complex computer operations.

Programmers. Computer programmer employment is expected to grow from 341,000 in 1980 to 500,000 in 1990, an increase of 47 percent. The overall demand for programmers will increase as less expensive and more sophisticated computer hardware and software attract new computer users and increase the number and type of computer applications among existing users.

More systems programmers will be needed to develop the complex operating programs made necessary by higher level languages and complicated computer configurations, as well as to link or coordinate the output of different programs from different systems. As increasing applications expand the computer market, the need for applications programmers also will increase, although not quite as rapidly as in the past as more people use "canned" programs to process data without the direct assistance of a programmer. Continuing development of programming instructions built into computer hardware, user-oriented languages, terminal programming by non-EDP personnel, and more standardized software packages are expected to simplify some job duties of applications programmers.

Computer and peripheral equipment operators. Employment of computer and peripheral equipment operators is expected to increase from 522,000 in 1980 to 850,000 in 1990, or by 63 percent. The major cause of this growth is the increasing use of computer hardware. The increased utilization of distributed data processing systems, and the concomitant rise in the number of minicomputers and other types of peripheral equipment, also will require increasingly large numbers of computer operating personnel.

Similarly, recent advances in miniaturizing circuits have enabled manufacturers to reduce both the size and cost of computer components. As the technology is further developed, a continued expansion in the use of computers is expected, especially by small businesses. As small business applications increase, many of these organizations are expected to install their own computer systems, thus generating additional demand for workers to operate the equipment.

Keypunch operators. Employment of keypunch operators is expected to decline from 266,000 in 1980 to 230,000 by 1990. This 14-percent decrease is the only projected employment decline among the computer occupations studied.

Data entry has long been considered a bottleneck in data processing operations. Cardpunch-oriented data entry systems in the past have produced slow, error prone, and increasingly costly performance in many computer operations. Further, the gap between machine speed and the time required for manual card input has widened due to advances in internal data processing capabilities of computers. These problems, along with expected increases in the volume of data to be processed, have spurred technological advances in alternative methods of data entry. These methods include computer terminals and other forms of direct keying, along with other data communications input systems. Users are expected to continue to employ these more efficient data entry methods, thus diminishing the need for keypunch operators.

Computer service technicians. Employment of computer service technicians is expected to show the largest increase of all the computer occupations—growing from 83,000 in 1980 to 160,000 in 1990, or by 93 percent.

The rising demand for computer service technicians is related to the growing number of computers in use and the geographic distribution of these computers. Continued reductions in the size and cost of computer hardware will bring the computer within reach of a rapidly increasing number of small organizations. As more and more of these small systems are installed, the amount of time technicians must spend traveling between clients also will increase, further intensifying the demand for these workers.

Expected employment growth by major industry division

Although computer employment is expected to grow substantially in all industries over the next decade, considerable variation is expected. Table 8 presents 1978 and projected 1990 computer employment by major industry division. The following sections describe the factors underlying computer employment growth in each of these industry groups.[5]

Manufacturing. Computer employment in manufacturing is expected to increase rapidly - by about 70 percent—over the period 1978 to 1990. Because computers are readily adaptable to manufacturing processes, this industry division had already made extensive use of computers by the early 1970's. Over the next decade, the manufacturing sector will continue to apply computers to process control, quality control, business forecasting, and management information functions such as accounting and personnel management. In addition, more intensive use will be made of existing systems; many of these will require additional computer personnel. Also, minicomputer systems will continue to be developed for specific manufacturing functions, such as product design and precision measurement. Some of

[5] As indicated earlier, the latest industry-occupational matrix available when this report was prepared presented employment of computer workers by industry for 1978. This section, therefore, describes employment change between 1978 and 1990.

Table 8. Employment in computer occupations by industry division, 1978 and projected 1990

Industry division	Total, all occupations			Systems analysts			Computer programmers		
	1978	1990	Percent change, 1978-90	1978	1990	Percent change, 1978-90	1978	1990	Percent change, 1978-90
Total, all industries	1,157,983	2,140,000	84.8	181,998	400,000	119.8	246,998	500,000	102.4
Agriculture, forestry, and fisheries	1,079	1,785	65.4	45	200	344.0	269	600	123.0
Mining	13,107	24,860	89.7	2,364	5,000	112.4	3,176	6,300	98.4
Construction	10,213	17,525	71.6	1,423	3,000	110.8	2,481	4,500	81.4
Manufacturing	320,270	552,400	72.5	61,915	119,500	93.0	73,830	129,000	74.7
Transportation, communication, and public utilities	65,506	107,130	63.5	8,215	17,700	115.5	12,445	23,000	84.8
Wholesale and retail trade	141,665	242,000	70.8	18,782	35,000	86.3	19,409	35,000	80.3
Finance, insurance, and real estate	152,498	266,900	75.0	14,388	30,100	109.6	26,300	51,000	93.9
Services	343,759	719,900	109.4	59,800	147,500	146.7	84,366	204,000	141.8
Government	116,695	207,500	77.8	21,914	42,000	91.7	24,722	46,600	88.5

Industry division	Computer service technicians			Computer and peripheral equipment operators			Keypunch operators		
	1978	1990	Percent change, 1978-90	1978	1990	Percent change, 1978-90	1978	1990	Percent change, 1978-90
Total, all industries	63,001	160,000	154.0	392,993	850,000	116.3	272,993	230,000	−15.8
Agriculture, forestry, and fisheries	5	10	100.0	337	625	85.5	423	350	−17.3
Mining	87	210	141.4	5,397	11,650	115.9	2,093	1,700	−18.8
Construction	95	200	110.5	3,641	7,725	112.2	2,573	2,100	−18.4
Manufacturing	15,914	44,000	157.6	103,093	215,000	108.5	65,518	47,900	−26.9
Transportation, communication, and public utilities	816	1,580	93.6	26,057	52,300	100.7	17,972	12,550	−30.2
Wholesale and retail trade	18,737	46,000	145.5	44,455	90,000	102.5	40,282	36,000	−10.6
Finance, insurance, and real estate	527	1,300	146.7	69,026	147,500	113.7	42,287	37,000	−12.5
Services	25,132	66,000	162.6	103,647	236,000	127.7	70,814	66,400	−6.2
Government	1,683	3,700	119.2	37,340	89,200	138.9	31,031	26,000	−16.2

SOURCE: Bureau of Labor Statistics.

the job functions traditionally carried out by computer personnel will be performed in the future by engineers, machinists, and other personnel using minicomputers.

Finally, computer terminals will be used more extensively but will have a mixed impact on computer employment. For example, terminals are used in warehouse inventory control and in research and development. Some data input will be handled by warehouse personnel and research scientists or engineers, decreasing the demand for keypunch operators. Greater terminal use, however, should increase the demand for systems analysts and programmers. Also, the larger amounts of computer equipment in use will further spur the need for additional computer service technicians.

Transportation, communications, and other public utilities. This industry division has been intensively computerized since the late 1960's. Consequently, it is expected to experience the smallest increase in computer employment through the 1980's, about 65 percent. Installing new computers and upgrading present computer systems—especially in the communications sector—will result in sharp employment increases for computer service technicians, systems analysts, and computer programmers. The demand for computer and peripheral equipment operators also is expected to increase with the greater utilization of computer terminals. The number of keypunch operators, however, is expected to decline, partially offsetting the gains registered in other occupations.

Wholesale and retail trade. Computer employment in wholesale and retail trade is expected to increase by about 70 percent, less than the average for all industries through the next decade. During the 1970's, both retailers and wholesalers increasingly adopted such practices as computerized ordering and inventory systems, as well as integrated point-of-sale credit authorization systems. These applications will gradually extend to the smaller establishments in the industry division, creating additional demand for computer workers.

Employment of systems analysts, programmers, and computer and peripheral equipment operators will all increase as small retailers and wholesalers increasingly computerize their operations. The largest percentage increase, however, is projected for computer service technicians due to the expected growth in the number of data processing terminals and associated communications devices. Employment of keypunch operators will decline as new data are captured at the source by noncomputer personnel such as sales clerks, or keyed in via terminals connecting branch outlets to the organization's main data base.

Finance, insurance, and real estate. Computer employment in this major industry sector will increase

sharply through the 1980's—by 75 percent—as more small and medium-sized companies adopt computer techniques already widely used by larger firms in the industry. Most of this employment increase will occur in the finance sector. More banks are expected to automate their teller operations, participate in automated check clearing facilities, and offer 24-hour banking services through the use of on-line terminals. In addition, rapidly emerging banking applications such as electronic funds transfer systems (EFTS) will generate expansion of computer staffs in financial institutions. Increased participation in centralized credit checking and authorization systems will spur the demand for computer workers in credit agencies. Within finance, the group expected to show the smallest employment gains are securities firms. These firms were extensively computerized in the 1970's, with the implementation of fully automated stock quotation facilities and a national system for clearing securities transactions.

Although overall employment in finance, insurance, and real estate is expected to increase rapidly, growth rates for the individual occupations will vary. Employment of computer service technicians will increase the most rapidly, due to the large numbers of terminals, minicomputers, and other data communications equipment in operation. The demand for systems analysts, programmers, and computer and peripheral equipment operators also will remain very strong as the industry continues to increase the number and types of applications as well as the volume of computer equipment. Keypunch operator employment will decline as more efficient methods of data entry are adopted.

Services. Services, the fastest growing industry division in the economy, are expected to show the greatest increase in computer employment through the 1980's; employment is expected to more than double over the period. An expanding market for data processing in hospitals, educational institutions, and, especially, computer service organizations will account for most of the increase. Demand for programmers and systems analysts will be strong as hospitals continue to computerize their medical information and communications systems, as well as automating the services they provide to patients. Employment requirements of these systems and of those for medical diagnosis and instruction will assure the need for computer specialists in hospitals.

Similar growth is expected in educational services as more computer-assisted instructional systems are developed, library operations such as acquisitions and cataloging continue to be automated, and administrative tasks including class scheduling and maintenance of student records are handled by computers. Because many medical and educational applications are expected to feature direct data entry by users, such as hospital record clerks or students, employment requirements for keypunch operators should decline.

The growth of computer service organizations also will contribute heavily to the overall increase for computer workers in this industry. Service firms will continue to need large numbers of computer and peripheral equipment operators as well as more systems analysts and programmers to design and implement systems for the growing number of applications for small businesses and other organizations. At the same time, computer maintenance companies will need many more computer service technicians to service the increasing stock of computer equipment. Several factors will contribute to a growing need for contract data processing services and the resulting demand by service firms for trained computer personnel. These sources of demand include a growing number of applications featuring computer-to-terminal interfacing or minicomputers, and the growing popularity of franchised data processing services that are expected to enlarge the market.

Several other sectors within this broad industry division will experience growth in computer employment. Hotels, for example, will continue to install computerized reservation systems; and business services such as accounting, credit reporting, and research will become increasingly computerized.

Government. Computer employment requirements in government will increase by about 80 percent through the 1980's, as new information systems are installed and existing ones expand their capabilities. State and local government agencies will experience the greatest growth in computer personnel as their potential for new computer applications is realized. Growth in Federal computer employment will be somewhat slower, but steady nevertheless, as data processing requirements continue to expand.

Currently, most State and local computer systems have been developed around a single functional area such as revenue collection and disbursement, payroll, or medical and insurance information processing. In the future, however, consolidated systems serving a greater variety of information processing needs and using terminal networks and other data communications technology will be developed.

Within government, employment of computer service technicians will grow dramatically—keeping pace with hardware sales and installations. Larger amounts of equipment in use will also spur the demand for computer and peripheral equipment operators. Requirements for programmers and systems analysts, especially at the State and local level, will also rise rapidly as law enforcement, voter registration, and traffic-oriented applications continue to be computerized. Keypunch operator employment, however, will decline as more efficient methods of data entry continue to be utilized.

Agriculture, forestry, and fisheries, mining, and construction. The number of people employed in the computer occupations in these industry divisions is so small that accurate employment projections cannot be made. It is expected, however, that computer employment in these industries will exhibit the same trends as in the overall economy.

Job openings

In addition to openings resulting from growth in the demand for computer workers, many jobs will become available each year as workers retire, die, leave the labor force for other reasons, or transfer to other occupations. Data on estimated annual job openings between 1980 and 1990 are presented in table 9. Total openings for each occupation consist of those resulting from employment change in that occupation and those stemming from the need to replace workers who leave the labor force for a variety of reasons. Although keypunch operator employment is expected to decline, for example, there will be many job openings in this large occupation as workers die or retire.

Sufficient data are not available to develop estimates of openings resulting from transfers of workers to other occupations. The limited data that are available, however, indicate significant mobility both within the computer field and for computer workers who transfer to other kinds of jobs. Programmers, for example, often advance to systems analyst jobs and many systems analysts become managers. To a lesser extent, a career ladder exists for computer operating personnel, with some of these workers advancing to programmer positions.

Implications of employment projections

The extremely rapid employment growth projected for the computer occupations will have a significant impact on education and training, wages, and other aspects of the labor market for computer workers. Some foreseeable trends are:

- The educational system will need to develop more programs to meet the continually rising demand for computer workers. Additionally, as computer use becomes more widespread, the trend toward infusing computer-related training into more curricula will accelerate.
- Shortages of computer workers are expected to become increasingly pronounced in the years ahead. As more and more workers are required to bring new computer applications on-line, competition among employers for skilled computer personnel will become increasingly intense. Thus, firms are likely to continue using aggressive recruiting techniques to fill their computer staffing requirements.
- The shortage of trained computer personnel is likely to result in a continued escalation of wages for these workers. Not only will entry salaries be driven up, but also the salaries of experienced workers in order to maintain an organization's internal salary structure.
- The great demand for computer personnel will make it more difficult to hire and retain workers in occupations requiring similar aptitudes. Math teachers, for example, are being lured away from public schools by the higher salaries in computer specialties. Colleges and universities also are finding it difficult to compete with business and government organizations to attract and retain computer science professors who may earn less than a beginning programmer. As the continuing upward pay spiral further discourages graduate study, schools will find it increasingly difficult to alleviate the teacher shortage.
- As electronic data processing operations grow in importance across all industries, the importance of and opportunities for skilled computer workers also will increase. Many companies, for example, now include data processing managers on their executive boards, a practice almost unheard of a decade ago. As data processing budgets expand and the coordination of computer operations becomes more complex, opportunities of this type are expected to become more prevalent.

In summary, the shortage of computer personnel is expected to continue, resulting in higher wages, more job mobility, increased job security, and generally greater opportunities for these workers. At the same time, this labor market imbalance will result in serious problems for employers as they attempt to maintain a stable computer staff.

Table 9. Projected average annual job openings in computer occupations, 1980-90

Occupation	Total average annual openings, 1980-90	Employment change	Replacement needs[1]
Total	94,700	68,500	26,200
Systems analysts	19,000	15,700	3,300
Programmers	20,550	15,900	4,650
Computer and peripheral equipment operators	41,800	32,800	9,000
Keypunch operators	3,900	-3,500	7,500
Computer service technicians	8,450	7,700	750

[1] Separations from the labor force due to deaths and retirements.
SOURCE: Bureau of Labor Statistics.

Appendix A. Methods

Sources of data

Data for this study were obtained from several sources. First, interviews were conducted with officials of the American Federation of Information Processing Societies, the International Data Corporation, and others. Various experts, including educators and government officials, also were interviewed.

Next, a search of existing literature was made to obtain available information on the employment and training of computer personnel. In addition, information was sought on computer use by specific industry, types of computer applications, and advances in computer technology.

These sources were supplemented by data from the Bureau of the Census and BLS, especially the BLS national industry-occupational matrix that provides detailed information on the distribution of occupational employment by industry. The employment projections presented in this report represent an interim revision of portions of that matrix to reflect the results of the study.

Framework for projections

Projections of employment for the economy as a whole and by industry were prepared by BLS and described in *Employment Projections for the 1980's*, BLS Bulletin 2030. A brief description of the assumptions that underlie these projections is presented in *Occupational Projections and Training Data*, BLS Bulletin 2052.

Computer employment projections presented in this study were developed within the framework of the latest BLS industry-occupational matrix. The most recently developed matrix presents data on occupational composition of all industry sectors for 1970, 1978, and 1990. Matrix staffing patterns reflect the 1970 Census industry-occupational employment estimates, updated by the Bureau's Current Population Survey that provides census-based occupational estimates for the years between the decennial censuses.

In-depth analysis of the computer occupations and evaluation of trends in the computer field led to an upward revision of the 1990 matrix employment projections for each of the computer occupations. These revised projections were then applied to the 1990 estimates of total employment for each of the 200 industries included in the matrix to yield new ratios showing the concentration of each computer occupation in each industry. The total number of computer workers per industry was obtained by summing across all of the computer occupations.

Change in matrix data base

The BLS is in the process of converting from an industry-occupational matrix based on census data to one based on the Occupational Employment Statistics (OES) survey.[1] These two data sources differ in several major respects:

Respondents. The census-based Current Population Survey (CPS) is a household survey, completed by an individual who responds for all members of the household. Persons who hold two or more jobs are only counted once, based on where they work the most hours each week. The OES survey is an establishment survey in which an official of the responding firm completes a questionnaire based on company records. Data from the OES survey count all jobs in each surveyed industry.

Time frame. Industry staffing patterns are available from the Census only every 10 years. The OES surveys are updated on a 3-year cycle, with staffing patterns benchmarked to the third year of the cycle.

Occupations. The CPS collects employment data for approximately 400 occupations. The data are categorized according to job titles that were used in the 1970 Census. The OES survey collects data for more than 1,800 occupations. Each occupation to be surveyed in a particular industry is defined on the questionnaire for that industry.

Industries. The CPS does not collect occupational employment by detailed industry. Staffing patterns from the latest decennial Census are updated based on estimates of occupational employment from the CPS and on estimates of industry employment from the Industry Employment Statistics (IES) survey. This produces occupational employment data for 200 industries. The OES survey collects occupational employment by detailed industry. Data are not collected in the agricultural or

[1] A background discussion of the OES survey may be found in the *BLS Handbook of Methods*, Bulletin 1910 (1976), pp.57-59.

private household industries—these are estimated. This procedure generates occupational employment data for 378 industries.

Preliminary findings indicate that the two surveys reported comparable levels of employment in 1978 for all of the computer occuptions except computer and peripheral equipment operators. Preliminary OES survey results show substantially fewer of these workers than were reported in the 1978 CPS. Differences in occupational classification are the most likely explanation for the different employment estimates. The 1970 Census lists general job titles (some of which are now outdated) that the respondent has to fit to job duties, whereas the OES survey has a specific definition included on each questionnaire that probably eliminated a number of workers from this category.

Appendix B. Industry Distribution of Computer Employment by Occupation, 1970, 1978, and Projected 1990

Table B-1. Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Total, all computer occupations						Computer programmers					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Total, all industries	766,183	0.97	1,184,791	1.23	2,140,000	1.88	176,496	0.22	246,998	0.26	500,000	0.44
Agriculture, forestry, fisheries	687	.02	1,078	.03	1,785	.06	149	–	269	.01	600	.02
Agriculture	419	.01	564	.02	885	.03	47	–	72	–	200	.01
Agricultural production	184	–	181	.01	230	.01	–	–	–	–	20	–
Services, except horticulture	226	.13	327	.14	500	.18	39	.02	52	.02	130	.04
Horticultural services	40	.03	76	.03	135	.06	8	.01	20	.01	50	.02
Forestry	149	.28	473	.59	775	1.09	90	.17	179	.23	350	.49
Fisheries	19	.04	25	.04	145	.23	12	.03	18	.03	50	.08
Mining	8,114	.97	13,107	1.48	24,860	2.35	1,752	.26	3,176	.36	6,300	.59
Metal mining	500	.53	646	.66	1,125	1.00	132	.14	159	.17	300	.27
Coal mining	179	.12	391	.18	700	.21	31	.02	55	.03	100	.03
Crude petroleum and natural gas	5,037	1.80	11,479	2.53	21,935	4.47	1,494	.54	2,847	.63	5,700	1.16
Nonmetallic mining, quarrying	398	.34	591	.48	1,100	.96	95	.08	115	.09	200	.17
Construction	7,048	.15	10,213	.17	17,525	.25	1,864	.04	2,481	.04	4,500	.07
General building contractors	852	.07	1,289	.09	2,425	.14	202	.02	312	.02	600	.03
General contractors, exc. building	5,274	.38	7,332	.47	12,385	.84	1,497	.11	1,856	.12	3,250	.17
Special trade contractors	919	.04	1,612	.06	2,715	.08	165	.01	314	.01	650	.02
Manufacturing	238,399	1.21	320,270	1.56	552,400	2.34	60,815	.31	73,830	.36	129,000	.55
Durable goods	169,844	1.49	235,027	1.90	421,700	2.90	47,474	.42	58,043	.47	104,500	.68
Ordnance	8,612	2.91	8,923	4.02	10,400	6.02	3,221	1.09	2,143	1.24	4,000	2.31
Lumber and wood products	1,439	.23	1,841	.27	2,850	.39	294	.05	381	.06	490	.07
Logging	71	.06	99	.08	140	.13	26	.02	36	.03	40	.04
Sawmills, planing mills	951	.24	1,136	.27	1,580	.34	195	.05	254	.06	290	.06
Misc. wood products	417	.34	606	.46	1,130	.67	74	.06	91	.07	160	.09
Furniture and fixtures	2,237	.48	3,011	.58	4,550	.67	388	.08	529	.10	820	.12
Stone, clay, and glass products	3,732	.58	4,983	.71	8,120	1.14	719	.11	895	.13	1,460	.20
Glass and glass products	1,214	.66	1,488	.74	2,460	1.11	254	.14	311	.15	560	.25
Cement, concrete, plaster	1,252	.56	1,727	.70	2,770	1.06	307	.14	385	.16	590	.23
Structural clay products	193	.33	188	.37	230	.72	37	.06	37	.07	40	.13
Pottery and related products	190	.43	272	.58	500	1.18	21	.05	27	.06	30	.07
Misc. nonmetallic stone	883	.66	1,308	.86	2,160	1.40	100	.07	135	.09	230	.15
Primary metal industries	11,043	.85	13,515	1.08	20,900	1.55	2,202	.17	2,549	.20	4,100	.30
Blast furnaces, steel works	5,402	.97	6,028	1.25	8,620	1.80	1,048	.19	1,129	.23	1,620	.34
Other primary steel	1,982	.54	2,499	.68	4,040	.95	404	.11	478	.13	840	.20
Primary aluminum	1,519	.97	2,275	1.27	3,690	2.04	324	.21	426	.24	730	.40
Other primary nonferrous	2,140	.96	2,713	1.19	4,550	1.76	426	.19	516	.23	910	.35
Fabricated metal products	9,999	.72	13,874	.90	22,670	1.21	1,980	.14	2,589	.17	4,550	.24
Cutlery, other hardware	1,664	1.10	2,209	1.23	3,510	1.54	267	.18	367	.20	690	.30
Fabricated metal products	2,799	.65	3,949	.79	6,780	.98	610	.14	825	.18	1,670	.24
Screw machine products	885	.83	1,075	.99	1,530	1.35	120	.11	147	.14	220	.19
Metal stamping	1,448	.62	2,142	.87	3,690	1.27	321	.14	407	.17	670	.23
Misc. metal products	3,215	.69	4,499	.88	7,160	1.32	642	.14	843	.16	1,300	.24
Machinery, except electrical	56,319	2.85	90,982	3.93	199,880	6.70	17,098	.86	24,318	1.05	51,190	1.72
Engines and turbines	1,551	1.41	2,354	1.78	4,190	2.93	394	.36	560	.42	890	.62
Farm machinery, equipment	2,004	1.56	2,747	1.84	4,680	2.60	429	.33	572	.38	920	.51
Construction machinery	3,847	1.31	5116	1.65	10,240	2.19	851	.29	1,253	.34	1,950	.42
Metalworking machinery	3,041	.96	4,488	1.29	7,820	1.79	759	.24	1,011	.29	1,900	.44
Office, accounting machinery	4,849	5.33	4,980	6.91	6,870	10.13	1,304	1.43	1,156	1.60	1,600	2.43
Electronic computing equipment	33,025	17.57	58,322	21.72	145,420	30.94	11,626	6.19	17,388	6.49	39,960	8.50
Machinery, n.e.c.	7,922	.93	11,975	1.23	20,660	1.67	1,735	.20	2,378	.24	3,970	.32
Electrical machinery	35,815	1.87	47,031	2.29	78,670	3.15	10,751	.56	12,002	.58	19,900	.80
Household appliances	1,968	1.06	2,370	1.30	3,940	1.85	407	.22	464	.25	620	.29
Radio, TV, communications equipment	15,891	2.52	18,763	3.14	27,100	4.12	5,062	.80	5,128	.86	7,300	1.11
Electrical machinery, n.e.c.	17,956	1.63	25,898	2.03	47,630	2.92	5,282	.48	6,410	.50	11,980	.73
Transportation equipment	28,727	1.50	36,814	1.73	50,660	2.14	8,172	.43	8,982	.43	12,200	.51
Motor vehicle equipment	9,111	1.13	13,827	1.41	22,400	1.96	1,999	.25	2,855	.29	5,180	.45
Aircraft and parts	16,706	2.51	18,213	3.10	22,540	4.39	5,448	.82	5,316	.91	5,990	1.17
Ship, boat building, repair	2,196	.80	2,592	.92	3,680	1.17	586	.21	594	.21	680	.22
Railroad equipment	445	.88	661	1.06	990	1.55	94	.19	125	.20	150	.23
Mobile dwellings	106	.12	195	.18	430	.18	8	.01	15	.01	40	.01
Cycles, misc. transportation equipment	163	.65	326	.77	610	.93	37	.15	77	.18	160	.24
Professional and scientific instruments	8,180	1.80	12,558	2.22	19,980	2.92	2,092	.46	2,956	.52	4,870	.71
Scientific instruments	3,168	1.79	4,454	2.27	6,330	3.23	816	.46	1,051	.54	1,430	.73
Optical, health service supplies	1,876	1.38	3,428	1.66	5,710	2.14	451	.33	791	.38	1,550	.58
Photo equipment and supplies	2,831	2.60	4,377	3.34	7,460	4.05	756	.69	1,040	.79	1,780	.97
Watches and clock devices	305	.97	299	.99	380	1.05	69	.22	74	.24	110	.30
Misc. manufacturing	3,552	.82	4,496	.97	5,930	1.18	577	.13	699	.15	930	.18
Nondurable goods	68,755	.84	85,783	1.04	131,700	1.45	13,141	.16	15,787	.19	25,500	.28
Food and kindred products	11,169	.63	13,589	.79	20,020	1.15	1,903	.11	2,157	.13	3,390	.20
Meat products	1,841	.53	2,290	.65	3,300	.93	266	.08	308	.09	540	.15
Dairy products	1,839	.67	1,598	.85	1,750	1.27	239	.10	218	.12	240	.17
Canning and preserving	1,741	.61	2,318	.77	3,840	1.06	384	.14	479	.16	820	.23
Grainmill products	913	.86	1,248	.85	1,880	1.20	155	.11	189	.13	290	.19
Bakery products	1,018	.37	1,190	.51	1,250	.61	156	.06	165	.07	230	.11
Confectionery products	843	.78	674	.87	860	1.07	111	.13	118	.15	140	.17
Beverages	1,588	.67	1,966	.86	2,900	1.24	273	.12	296	.13	350	.15
Misc. food preparations	1,786	.99	2,309	1.24	3,380	1.66	319	.18	384	.21	580	.28
Tobacco manufacturing	788	.96	817	1.21	880	1.49	204	.25	192	.29	200	.35
Textile mill products	6,421	.68	7,134	.79	10,370	.98	1,143	.12	1,262	.14	1,960	.19
Knitting mills	1,472	.60	1,564	.66	2,220	.66	208	.08	237	.10	380	.11
Dyeing, finishing textiles	662	.78	781	.99	1,155	1.50	118	.14	131	.17	190	.25
Floor coverings	861	1.51	1,134	1.85	2,080	2.01	151	.26	184	.30	360	.35
Yarn, fabric mills	2,982	.57	3,211	.71	4,345	.95	561	.11	599	.13	890	.19
Misc. textile mill products	456	.81	454	.85	570	.89	106	.14	111	.16	160	.19
Apparel, textile products	6,208	.45	7,093	.53	10,750	.69	894	.06	1,058	.08	2,000	.13
Apparel and accessories	5,482	.46	6,203	.54	9,380	.71	805	.07	946	.08	1,780	.13
Misc. fabricated products	724	.43	890	.46	1,390	.59	89	.05	112	.06	220	.09
Paper and allied products	5,886	.83	6,899	.99	11,250	1.42	1,036	.15	1,149	.17	2,100	.27
Pulp, paper, paperboard mills	2,944	1.01	3,320	1.25	5,130	2.01	582	.20	599	.23	1,010	.39
Paperboard containers, boxes	1,033	.46	1,040	.49	1,540	.58	183	.08	191	.09	380	.14
Misc. paper and pulp products	1,908	1.01	2,539	1.16	4,580	1.71	271	.14	359	.16	710	.26

See notes at end of table.

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Total, all computer occupations						Computer programmers					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Printing and publishing	12,220	1.05	15,921	1.26	25,740	1.92	2,199	0.19	3,101	0.25	5,590	0.42
Newspaper publishing, printing	2,281	.55	3,223	.70	5,570	1.05	440	.11	552	.12	1,050	.20
Printing, publishing, exc. newspaper	9,939	1.34	12,698	1.58	20,170	2.48	1,759	.24	2,549	.32	4,540	.56
Chemical and allied products	13,734	1.33	18,144	1.88	31,020	2.33	3,193	.31	3,851	.36	6,400	.48
Industrial chemicals	4,389	1.38	5,526	1.70	10,010	2.54	1,317	.41	1,493	.46	2,700	.69
Plastics, synthetics	1,042	1.02	1,361	1.41	2,370	2.18	272	.27	298	.31	410	.38
Synthetic fibers	1,128	1.04	1,425	1.22	2,530	1.40	226	.21	271	.23	520	.29
Drugs and medicines	2,778	1.94	4,436	2.39	7,880	3.57	614	.34	912	.49	1,550	.70
Soaps and cosmetics	2,034	1.63	2,577	1.92	4,040	2.43	345	.28	416	.31	590	.35
Paints and varnishes	1,018	1.49	1,278	1.77	2,000	2.17	127	.19	161	.22	230	.25
Agricultural chemicals	557	1.01	777	1.27	1,220	2.14	124	.23	156	.26	190	.33
Misc. chemicals	798	.72	764	.89	970	.85	168	.15	144	.17	210	.18
Petroleum and coal products	5,141	2.70	6,883	3.30	9,750	5.48	1,280	.67	1,503	.72	1,950	1.10
Petroleum refining	4,807	3.13	6,449	3.92	9,090	7.48	1,250	.81	1,464	.89	1,890	1.56
Misc. petroleum, coal products	334	.91	434	.99	660	1.17	30	.08	39	.09	60	.11
Rubber, misc. plastic products	5,294	.92	6,957	.93	10,760	1.34	1,000	.17	1,231	.16	1,800	.22
Rubber products	3,674	1.26	4,162	1.41	5,750	1.70	760	.26	822	.28	1,010	.30
Misc. plastic products	1,620	.56	2,795	.82	5,010	1.08	240	.08	409	.09	790	.17
Leather products	1,897	.59	1,826	.71	2,040	.95	289	.09	283	.11	310	.14
Leather tanning, finishing	109	.42	106	.47	140	1.02	7	.03	7	.03	10	.07
Footwear, except rubber	1,319	.58	1,217	.71	1,200	.91	223	.10	211	.12	220	.17
All other leather products	469	.68	503	.79	700	1.02	59	.09	65	.10	80	.12
Transportation, other public utilities	48,606	.97	65,505	1.13	107,130	1.69	9,345	.19	12,445	.22	23,000	.36
Transportation, total	20,130	.70	23,966	.73	32,780	.93	3,095	.11	3,994	.12	5,500	.16
Railroads, railway express	8,186	1.33	6,937	1.36	6,225	1.45	768	.12	689	.13	650	.15
Local, interurban transit	540	.14	595	.13	880	.16	60	.02	73	.02	100	.02
Street railways, bus lines	516	.18	558	.16	845	.20	56	.02	65	.02	90	.02
Taxicab service	24	.03	37	.03	35	.03	4	—	8	.01	10	.01
Trucking and warehousing	4,343	.37	5,739	.39	8,035	.52	564	.06	814	.06	1,300	.08
Trucking services	3,829	.36	5,129	.38	7,195	.50	490	.06	730	.06	1,160	.08
Warehousing and storage	514	.56	610	.65	840	.81	64	.07	84	.09	140	.14
Water transportation	1,108	.47	1,293	.53	1,720	.81	258	.11	368	.15	450	.21
Air transportation	4,522	1.31	6,822	1.83	11,080	2.10	1,155	.34	1,486	.36	2,100	.40
Pipelines	367	2.17	537	2.81	856	3.52	113	.67	147	.77	160	1.00
Transportation services	1,066	1.00	2,043	1.20	3,990	1.57	187	.17	317	.19	740	.29
Communications, utilities, sanitary services	28,475	1.32	41,539	1.69	74,350	2.85	6,250	.29	8,551	.35	17,500	.62
Communications	16,286	1.51	23,992	1.99	48,525	3.50	3,300	.31	4,628	.38	10,450	.75
Telephone (wire and radio)	14,660	1.62	21,097	2.19	43,450	4.02	2,887	.32	3,985	.41	9,100	.84
Telegraph, misc. comm. services	1,004	2.11	1,931	3.06	3,160	5.17	276	.58	445	.70	850	1.39
Radio broadcasting, TV	622	.48	964	.54	1,825	.75	137	.11	198	.11	450	.18
Utilities, sanitary services	12,190	1.13	17,547	1.39	25,825	1.82	2,950	.27	3,923	.31	7,100	.50
Electric light and power	4,343	1.33	7,080	1.61	10,505	2.54	1,069	.33	1,710	.39	3,400	.81
Electric—gas utilities	3,994	2.04	4,847	2.36	7,210	3.08	832	.42	989	.48	1,700	.73
Gas, steam supply systems	2,854	1.72	3,507	2.11	4,725	2.83	858	.52	975	.59	1,500	.90
Water supply	758	.57	1,060	.69	1,800	.85	141	.11	185	.12	300	.16
Sanitary services	152	.08	950	.33	1,460	.36	28	.01	37	.01	110	.03
Other utilities, n.e.c.	84	1.25	103	1.45	225	2.21	22	.33	27	.38	90	.88
Wholesale and retail trade	93,137	.57	141,665	.69	242,000	.95	13,550	.08	19,409	.09	35,000	.14
Wholesale trade	62,738	1.59	94,614	1.96	164,640	3.08	9,695	.25	13,663	.28	24,000	.45
Wholesale, except misc. wholesale	50,264	1.90	78,236	2.35	140,950	3.77	7,955	.30	11,347	.34	21,100	.54
Motor vehicles and equipment	4,309	1.30	6,441	1.50	9,180	1.76	543	.16	810	.19	1,450	.28
Drugs, chemicals allied products	5,006	2.15	6,250	2.32	8,220	2.82	670	.29	832	.31	1,250	.43
Dry goods and apparel	2,041	1.30	2,444	1.46	3,370	1.75	300	.19	369	.22	450	.23
Food and related products	5,927	1.02	7,767	1.16	10,680	1.49	865	.15	1,155	.17	1,550	.22
Farm products—raw materials	633	.60	1,138	.73	1,620	1.61	118	.11	208	.13	300	.30
Electrical goods	4,766	1.50	6,871	1.78	10,120	2.20	664	.21	908	.24	1,400	.30
Hardware, plumbing	1,762	1.03	2,131	1.02	2,760	1.23	267	.16	378	.18	500	.22
Machinery, equipment, supplies	25,810	3.46	45,394	4.28	98,190	7.99	4,528	.61	6,687	.63	13,200	1.07
Misc. wholesale trade	12,484	.97	16,378	1.10	24,150	1.50	1,740	.13	2,316	.16	3,900	.24
Metals and minerals, n.e.c.	1,362	1.01	1,673	1.19	2,415	1.48	170	.13	200	.14	350	.21
Petroleum products	2,336	1.17	2,527	1.08	3,015	1.26	458	.23	622	.27	1,100	.46
Scrap and waste material	82	.08	155	.12	315	.27	15	.01	26	.02	50	.04
Alcoholic beverages	1,362	1.37	2,042	1.56	2,760	2.22	118	.12	183	.14	250	.20
Paper and its products	1,343	1.01	1,601	1.22	2,270	1.40	146	.11	168	.13	200	.12
Lumber, construction materials	708	.44	955	.54	1,440	.67	92	.06	110	.06	150	.07
Wholesale trade, n.e.c.	5,299	1.14	7,425	1.37	11,940	2.01	741	.16	1,007	.19	1,800	.30
Retail trade	30,399	.24	47,051	.30	77,360	.38	3,855	.03	5,746	.04	11,000	.05
Building materials	937	.16	1,311	.18	1,940	.24	149	.03	215	.03	300	.04
Lumber, building materials	549	.15	921	.19	1,450	.30	87	.02	139	.03	200	.04
Hardware and farm equipment	388	.17	390	.16	490	.15	62	.03	76	.03	100	.03
General merchandise, total	15,537	.61	22,727	.77	37,420	.87	1,956	.08	2,819	.10	6,200	.14
Department, mail order	11,845	.76	18,570	.96	31,615	1.06	1,498	.10	2,327	.12	5,550	.19
Limited price stores	1,001	.32	1,065	.38	1,490	.45	95	.03	106	.04	150	.05
Vending machine operators	273	.40	324	.43	505	.39	25	.04	25	.03	50	.04
Direct selling	724	.22	782	.22	850	.25	168	.05	165	.05	200	.06
Misc. merchandise stores	1,694	.58	1,984	.66	2,960	.60	170	.06	196	.07	250	.05
Food and dairy stores	3,996	.20	6,553	.28	11,500	.39	476	.02	733	.03	1,360	.05
Grocery stores	3,676	.22	5,975	.30	10,400	.40	452	.03	698	.03	1,290	.05
Dairy product stores	124	.34	219	.49	350	.84	12	.03	19	.04	30	.07
Retail bakeries	115	.10	231	.17	530	.35	8	.01	13	.01	20	.01
Food stores, n.e.c.	81	.07	128	.09	220	.15	4	—	3	—	10	.01
Auto dealers, gas stations	1,306	.07	2,034	.10	3,100	.14	103	.01	155	.01	200	.01
Motor vehicle dealers	752	.10	1,064	.12	1,585	.16	72	.01	100	.01	125	.01
Tire, battery, accessory stores	515	.28	915	.35	1,460	.40	31	.02	55	.02	75	.02
Apparel and accessories	2,220	.29	3,303	.36	5,080	.45	208	.03	292	.03	450	.04
Apparel, accessory stores	1,843	.27	2,481	.33	3,840	.43	135	.02	181	.02	300	.03
Shoe stores	377	.38	822	.47	1,240	.53	73	.05	111	.06	150	.06
Furniture and appliances	1,421	.26	2,237	.33	3,940	.49	254	.05	401	.06	750	.09
Home furnishing stores	658	.19	943	.23	1,620	.32	86	.02	123	.03	240	.05
Appliances, TV, radio stores	763	.36	1,294	.48	2,320	.76	168	.08	278	.10	510	.17
Eating and drinking places	1,108	.04	2,736	.06	4,310	.08	103	—	166	—	250	—

See notes at end of table.

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Total, all computer occupations						Computer programmers					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Misc. retail trade stores	3,874	0.28	6,150	0.33	10,070	0.42	606	0.04	965	0.05	1,500	0.06
Drug stores	1,028	.22	1,338	.27	2,060	.31	174	.04	245	.05	400	.06
Liquor stores	103	.06	147	.09	210	.10	12	.01	21	.01	40	.02
Farm, garden supply stores	235	.20	447	.27	720	.39	49	.04	86	.05	120	.07
Jewelry stores	260	.24	401	.30	680	.42	27	.03	47	.03	90	.06
Fuel and ice dealers	577	.50	657	.60	895	.86	50	.04	52	.05	50	.05
Retail florists	12	.01	16	.01	20	.01	–	–	–	–	–	–
Misc. retail trade stores	1,669	.36	3,144	.45	5,495	.62	294	.06	514	.07	800	.09
Finance, insurance, real estate	103,858	2.72	162,498	3.03	266,900	4.11	20,430	.53	28,300	.52	51,000	.79
Finance, total	52,796	3.27	90,813	4.23	172,890	5.66	9,039	.56	13,440	.63	28,300	.93
Banking	39,878	4.02	69,386	5.20	135,990	7.02	6,656	.67	9,915	.74	22,100	1.14
Credit agencies	6,306	1.76	12,138	2.38	20,700	2.68	1,153	.32	1,997	.39	4,200	.54
Stock brokers, investment	6,612	2.49	9,309	3.09	15,200	4.41	1,230	.46	1,528	.51	2,000	.58
Insurance	49,211	3.84	68,871	3.86	89,780	4.58	11,078	.82	12,388	.77	22,000	1.12
Real estate	1,851	.22	2,814	.22	4,230	.29	313	.04	472	.04	700	.05
Services, total	184,994	.90	343,789	1.26	719,900	2.06	50,531	.24	84,366	.31	204,000	.58
Hotels and lodging places	688	.07	1,171	.09	2,220	.12	99	.01	152	.01	270	.01
Hotels and motels	586	.08	1,110	.12	2,155	.16	99	.01	152	.02	270	.02
Lodging place, except hotels	102	.03	61	.02	65	.01	–	–	–	–	–	–
Other personal services	809	.06	587	.04	610	.04	51	–	42	–	40	–
Laundry, cleaning	804	.13	578	.13	610	.20	51	.01	42	.01	40	.01
Misc. business services	90,262	5.52	169,570	6.36	376,610	9.02	26,071	1.59	44,023	1.65	112,300	2.69
Advertising	854	.66	1,063	.71	1,560	1.05	214	.17	258	.17	380	.24
Business management services	6,849	3.83	13,062	4.72	28,050	6.08	1,938	1.09	3,399	1.23	8,600	1.86
Commercial R&D	4,029	4.60	8,331	6.15	20,930	9.23	1,797	2.05	3,297	2.43	8,800	3.88
Computer programming	58,861	52.26	110,361	57.46	255,580	70.99	19,366	17.26	31,799	16.55	79,660	22.13
Detective and protective	407	.29	937	.33	2,180	.46	82	.06	181	.06	480	.10
Employment, temporary help	6,725	3.12	9,412	2.44	10,410	1.66	307	.14	640	.17	1,600	.25
Services to buildings	36	.01	66	.01	150	.02	–	–	–	–	–	–
Other misc. services	12,701	2.68	26,336	3.36	57,750	5.40	2,367	.50	4,449	.57	12,800	1.20
Automobile repair services	780	.16	1,232	.17	2,190	.25	105	.02	151	.02	310	.03
Auto repair	39	.01	186	.03	390	.07	–	–	–	–	–	–
Auto services, except repair	741	.44	1,066	.49	1,800	.60	105	.06	151	.07	310	.10
Other repair services	2,128	.87	4,244	.94	12,700	2.57	–	–	–	–	–	–
Electrical repair shops	993	.79	1,339	1.02	4,200	2.29	–	–	–	–	–	–
Other repair services	1,135	.59	2,905	.91	8,500	2.74	–	–	–	–	–	–
Motion pictures, theaters	862	.36	827	.40	1,070	.35	189	.08	181	.09	210	.07
Misc. entertainment	291	.07	741	.10	1,280	.15	44	.01	121	.02	340	.04
Medical, other health	13,554	.29	26,371	.39	57,970	.53	2,495	.05	4,642	.07	13,500	.12
Hospitals	11,538	.39	21,232	.54	48,430	.83	2,016	.07	3,499	.09	10,710	.18
Convalescent institutions	156	.03	501	.06	1,790	.06	27	.01	66	.01	390	.02
Health services, n.e.c.	1,860	.68	4,638	.67	8,750	.94	452	.16	1,077	.16	2,400	.26
Legal services	201	.05	365	.06	690	.09	30	.01	64	.01	160	.02
Educational services	33,927	.56	58,066	.77	102,840	1.28	11,785	.20	17,713	.24	33,000	.41
Elementary, secondary	4,461	.11	7,596	.15	11,430	.22	1,048	.03	1,620	.03	3,000	.06
Colleges and universities	26,507	1.68	45,195	2.24	80,720	3.58	10,047	.64	14,887	.74	27,500	1.22
Libraries	160	.20	435	.42	1,270	.84	54	.07	124	.12	400	.26
Educational services, n.e.c.	2,799	1.13	4,840	1.31	9,420	1.91	636	.25	1,082	.29	2,100	.43
Museums, art galleries, zoos	47	.16	119	.23	320	.35	16	.06	30	.06	70	.08
Nonprofit organizations	6,372	.45	9,816	.50	15,350	.62	950	.07	1,495	.08	2,800	.11
Religious organizations	587	.10	924	.13	1,070	.14	–	–	–	–	–	–
Welfare services	2,837	.86	4,191	.85	6,870	.71	423	.10	686	.11	1,200	.13
Nonprofit membership organizations	2,928	.77	4,478	.91	7,590	1.25	527	.14	809	.16	1,600	.26
Other professional, related services	35,073	4.26	70,850	5.47	148,050	8.94	8,696	1.06	15,752	1.22	41,000	2.51
Engineering and architectural services	3,470	1.09	8,169	1.86	20,210	3.22	1,317	.41	2,462	.50	8,100	1.29
Misc. professional services	5,002	2.42	9,943	2.76	23,840	5.51	1,969	.95	3,449	.96	10,900	2.52
Government, total	82,343	1.94	116,695	2.31	207,500	3.49	18,260	.43	24,722	.49	46,600	.78
Federal public administration	52,551	2.32	68,319	3.01	101,675	4.26	12,785	.57	15,277	.67	20,800	.86
Postal service	712	.10	1,637	.24	3,800	.57	143	.02	278	.04	600	.09
Other Federal public administration	51,869	3.35	66,682	4.19	97,875	5.68	12,642	.82	14,999	.94	20,000	1.16
State public administration	18,504	3.00	30,099	3.33	63,025	5.56	3,185	.52	5,629	.62	14,000	1.24
Local public administration	11,288	.82	18,277	.99	42,800	1.76	2,290	.17	3,816	.21	12,000	.49

See notes at end of table.

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Computer systems analysts						Computer and peripheral equipment operators					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Total, all industries	102,697	0.13	181,998	0.20	400	0.35	149,995	0.19	392,993	0.42	850,000	0.75
Agriculture, forestry, fisheries	18	–	45	–	200	.01	122	–	337	.01	625	.02
Agriculture	8	–	17	–	75	–	89	–	216	.01	380	.01
Agricultural production	–	–	–	–	10	–	35	–	61	–	120	.01
Services, except horticulture	8	–	17	.01	50	.02	47	.03	136	.06	220	.07
Horticultural services	–	–	–	–	15	.01	7	–	19	.01	40	.02
Forestry	10	.02	28	.04	85	.12	26	.05	97	.12	190	.27
Fisheries	–	–	–	–	40	.06	7	.02	24	.03	55	.09
Mining	969	.15	2,364	.28	5,000	.47	1,634	.26	5,397	.61	11,650	1.10
Metal mining	80	.09	129	.14	250	.22	84	.09	182	.19	400	.35
Coal mining	13	.01	35	.02	100	.03	60	.04	208	.10	450	.13
Crude petroleum and natural gas	840	.30	2,132	.47	4,500	.92	1,361	.49	4,707	1.04	10,150	2.07
Nonmetallic mining, quarrying	36	.04	58	.05	150	.13	129	.11	300	.24	650	.58
Construction	839	.02	1,423	.03	3,000	.04	1,432	.03	3,841	.06	7,725	.11
General building contractors	81	.01	184	.01	400	.02	155	.01	409	.03	1,100	.06
General contractors, exc. building	648	.06	1,106	.07	2,350	.12	1,121	.08	2,576	.17	5,300	.26
Special trade contractors	110	–	153	–	250	.01	156	.01	856	.02	1,325	.04
Manufacturing	38,002	.20	61,915	.30	119,500	.51	45,967	.23	103,093	.50	215,000	.91
Durable goods	31,103	.27	50,977	.41	99,500	.88	30,262	.27	68,915	.56	145,000	1.00
Ordnance	2,138	.72	1,951	1.14	3,100	1.79	1,831	.55	1,995	1.16	2,700	1.56
Lumber and wood products	179	.03	293	.04	550	.07	286	.05	658	.10	1,450	.20
Logging	–	–	–	–	–	–	14	.01	37	.03	80	.06
Sawmills, planing mills	130	.03	211	.05	370	.08	136	.04	311	.07	670	.14
Misc. wood products	49	.04	82	.06	180	.11	136	.11	310	.24	700	.41
Furniture and fixtures	142	.03	242	.05	420	.08	500	.11	1,187	.23	2,370	.35
Stone, clay, and glass products	431	.07	706	.10	1,360	.19	959	.15	2,152	.31	4,400	.62
Glass and glass products	158	.08	249	.13	480	.22	231	.12	523	.26	1,150	.52
Cement, concrete, plaster	150	.07	238	.10	440	.17	336	.15	747	.30	1,500	.58
Structural clay products	10	.02	14	.03	20	.06	37	.06	68	.13	170	.36
Pottery and related products	11	.03	18	.04	30	.07	61	.14	152	.32	380	.90
Misc. nonmetallic stone	102	.06	186	.12	390	.26	294	.22	662	.44	1,250	.81
Primary metal industries	1,214	.09	1,878	.15	2,900	.22	2,417	.19	5,061	.40	11,000	.82
Blast furnaces, steel works	590	.11	803	.17	1,170	.24	1,165	.21	2,216	.46	4,500	.94
Other primary steel	137	.04	242	.07	380	.09	484	.13	1,062	.29	2,300	.54
Primary aluminum	276	.18	508	.29	870	.48	306	.20	786	.43	1,800	.88
Other primary nonferrous	211	.09	325	.14	480	.19	462	.21	1,017	.44	2,600	1.00
Fabricated metal products	904	.06	1,620	.10	2,700	.14	2,258	.16	5,520	.36	12,080	.65
Cutlery, other hardware	179	.11	333	.19	610	.27	274	.18	686	.38	1,500	.66
Fabricated metal products	270	.06	508	.10	910	.13	591	.14	1,499	.30	3,380	.49
Screw machine products	77	.08	124	.11	190	.17	175	.17	409	.38	850	.75
Metal stamping	86	.04	156	.06	280	.10	426	.18	1,010	.41	2,250	.77
Misc. metal products	290	.06	499	.09	710	.13	792	.17	1,916	.37	4,100	.75
Machinery, except electrical	13,131	.87	24,490	1.06	54,500	1.83	7,674	.39	20,163	.87	51,500	1.73
Engines and turbines	243	.22	447	.34	830	.58	280	.25	736	.56	1,900	1.33
Farm machinery, equipment	215	.17	362	.24	550	.31	395	.31	974	.65	2,500	1.39
Construction machinery	672	.23	1,283	.35	2,500	.54	679	.23	1,822	.49	4,100	.88
Metalworking machinery	300	.09	515	.15	1,020	.23	713	.22	1,764	.51	3,800	.87
Office, accounting machinery	1,006	1.19	1,254	1.74	1,800	2.43	621	.68	1,049	1.46	1,800	2.73
Electronic computing equipment	9,864	5.25	19,286	7.20	45,400	9.66	3,198	1.70	9,283	3.46	27,000	5.74
Machinery, n.e.c.	752	.09	1,343	.14	2,600	.21	1,788	.21	4,535	.47	10,400	.84
Electrical machinery	5,977	.31	9,362	.45	16,870	.67	6,641	.35	14,525	.71	31,000	1.24
Household appliances	274	.15	411	.23	720	.34	392	.21	829	.45	2,100	.99
Radio, TV, communications equipment	2,694	.43	3,804	.63	6,100	.93	2,971	.47	5,591	.93	9,900	1.51
Electrical machinery, n.e.c.	3,009	.27	5,147	.40	10,050	.62	3,278	.30	8,105	.64	19,000	1.17
Transportation equipment	5,285	.28	7,504	.36	11,900	.50	5,668	.30	11,919	.58	20,800	.88
Motor vehicle equipment	1,204	.15	2,219	.23	4,400	.38	1,937	.24	5,064	.51	9,590	.84
Aircraft and parts	3,573	.56	4,855	.80	6,380	1.24	3,115	.47	5,477	.93	8,300	1.62
Ship, boat building, repair	326	.12	462	.16	690	.22	483	.18	972	.34	1,900	.60
Railroad equipment	63	.13	130	.21	210	.33	76	.15	203	.33	450	.70
Mobile dwellings	13	.02	35	.03	90	.03	25	.03	88	.08	250	.09
Cycles, misc. transportation equipment	5	.02	13	.03	30	.05	32	.13	126	.29	310	.47
Professional and scientific instruments	1,408	.31	2,490	.44	4,510	.66	1,518	.33	3,986	.70	7,400	1.08
Scientific instruments	623	.35	1,031	.53	1,800	.82	536	.30	1,255	.64	2,160	1.10
Optical, health service supplies	210	.15	465	.23	970	.36	335	.25	1,087	.53	2,100	.79
Photo equipment and supplies	554	.50	966	.74	1,900	1.03	615	.56	1,546	1.18	3,000	1.63
Watches and clock devices	21	.07	28	.09	40	.11	32	.10	77	.25	140	.39
Misc. manufacturing	295	.06	442	.09	790	.16	710	.16	1,770	.39	3,000	.60
Nondurable goods	6,899	.08	10,938	.13	20,000	.22	15,705	.19	34,718	.41	70,000	.77
Food and kindred products	877	.05	1,279	.07	2,250	.13	2,851	.16	6,177	.36	11,900	.69
Meat products	72	.02	106	.03	180	.05	447	.13	1,055	.30	2,050	.58
Dairy products	158	.07	195	.11	270	.20	382	.16	863	.36	1,020	.74
Canning and preserving	143	.06	207	.08	410	.11	455	.16	1,006	.34	2,100	.58
Grainmill products	79	.06	128	.08	230	.15	279	.20	637	.44	1,200	.77
Bakery products	27	.01	54	.02	90	.04	281	.10	599	.26	750	.37
Confectionery products	45	.08	84	.08	100	.12	137	.17	276	.36	510	.64
Beverages	119	.05	183	.07	260	.11	471	.20	1,012	.44	2,040	.87
Misc. food preparations	234	.13	382	.19	580	.28	399	.22	929	.50	1,800	.88
Tobacco manufacturing	68	.08	87	.13	130	.23	209	.26	357	.53	430	.74
Textile mill products	509	.06	748	.08	1,410	.13	1,284	.13	2,856	.30	5,500	.52
Knitting mills	68	.03	96	.04	190	.06	226	.09	483	.20	1,250	.37
Dyeing, finishing textiles	47	.06	77	.10	130	.17	182	.22	369	.47	700	.91
Floor coverings	68	.12	104	.17	220	.21	236	.41	545	.89	1,300	1.28
Yarn, fabric mills	285	.06	403	.09	740	.16	609	.12	1,196	.26	2,100	.46
Misc. textile mill products	41	.05	68	.10	130	.18	31	.04	63	.09	150	.18
Apparel, textile products	386	.03	589	.04	1,090	.07	1,146	.08	2,625	.20	5,900	.38
Apparel and accessories	344	.03	509	.04	930	.07	1,016	.08	2,286	.20	5,150	.39
Misc. fabricated products	42	.02	80	.04	160	.07	130	.08	340	.17	750	.32
Paper and allied products	643	.09	975	.14	1,760	.22	1,335	.19	2,716	.39	5,800	.73
Pulp, paper, paperboard mills	380	.12	482	.18	780	.30	765	.26	1,443	.54	2,900	1.13
Paperboard containers, boxes	67	.03	104	.05	220	.08	200	.09	396	.18	700	.26
Misc. paper and pulp products	216	.12	389	.18	760	.28	370	.20	887	.41	2,200	.82

See notes at end of table.

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Computer systems analysts						Computer and peripheral equipment operators					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Printing and publishing	918	0.08	1,894	0.13	3,350	0.25	3,029	0.26	6,756	0.54	13,900	1.04
Newspaper publishing, printing	109	.02	147	.03	280	.05	778	.19	1,781	.39	3,600	.68
Printing, publishing, exc. newspaper	809	.10	1,547	.19	3,070	.38	2,251	.30	4,975	.62	10,300	1.27
Chemical and allied products	2,053	.20	3,333	.31	6,810	.60	3,076	.30	6,737	.62	14,900	1.12
Industrial chemicals	700	.22	1,044	.32	2,140	.54	943	.30	1,934	.59	4,490	1.14
Plastics, synthetics	139	.14	234	.24	420	.39	313	.31	610	.63	1,390	1.28
Synthetic fibers	165	.16	277	.23	580	.32	209	.19	473	.40	1,130	.62
Drugs and medicines	609	.43	1,137	.82	2,250	1.02	546	.38	1,479	.80	3,300	1.50
Soaps and cosmetics	212	.17	320	.24	610	.37	448	.36	1,002	.76	2,200	1.32
Paints and varnishes	85	.13	139	.19	270	.29	247	.36	554	.77	1,200	1.30
Agricultural chemicals	49	.09	80	.13	150	.26	157	.29	363	.60	740	1.30
Misc. chemicals	104	.06	102	.12	190	.17	213	.19	322	.37	450	.40
Petroleum and coal products	919	.49	1,373	.86	1,950	1.10	1,149	.60	2,596	1.25	4,900	2.76
Petroleum refining	884	.57	1,312	.80	1,830	1.51	1,094	.71	2,444	1.49	4,520	3.72
Misc. petroleum, coal products	35	.09	61	.14	120	.21	55	.15	152	.35	380	.68
Rubber, misc. plastic products	403	.07	704	.09	1,330	.17	1,248	.22	2,860	.38	6,100	.76
Rubber products	282	.10	402	.14	710	.21	869	.30	1,656	.56	3,300	.97
Misc. plastic products	121	.04	302	.07	620	.13	379	.13	1,204	.27	2,800	.60
Leather products	123	.04	156	.06	250	.12	378	.12	687	.27	1,100	.51
Leather tanning, finishing	–	–	–	–	–	–	28	.11	57	.25	100	.73
Footwear, except rubber	59	.02	65	.03	90	.07	257	.11	458	.27	650	.49
All other leather products	64	.09	91	.14	160	.23	93	.13	182	.28	350	.51
Transportation, other public utilities	4,788	.09	8,215	.14	17,700	.28	10,834	.22	26,057	.45	52,300	.83
Transportation, total	1,611	.06	2,642	.08	4,700	.13	4,232	.15	9,256	.28	17,100	.49
Railroads, railway express	457	.08	596	.12	800	.19	1,624	.26	2,619	.51	3,200	.75
Local, interurban transit	35	.01	50	.01	75	.01	130	.03	290	.06	600	.11
Street railways, bus lines	31	.01	41	.01	60	.01	130	.04	290	.08	600	.14
Taxicab service	4	–	9	.01	15	.01	–	–	–	–	–	–
Trucking and warehousing	212	.01	392	.02	725	.05	803	.07	2,143	.15	4,200	.27
Trucking services	188	.01	365	.02	685	.05	688	.06	1,863	.14	3,700	.26
Warehousing and storage	24	.03	27	.03	40	.04	115	.13	280	.30	500	.48
Water transportation	122	.05	205	.08	400	.19	144	.06	296	.12	600	.28
Air transportation	609	.18	1,017	.24	1,800	.34	1,228	.36	2,956	.71	6,000	1.14
Pipelines	39	.23	60	.31	100	.63	94	.56	222	1.16	500	3.13
Transportation services	137	.13	322	.19	800	.31	209	.20	730	.43	2,000	.79
Communications, utilities, sanitary services	3,177	.15	5,573	.22	13,000	.46	6,602	.31	16,801	.68	35,200	1.25
Communications	1,970	.18	3,531	.29	9,000	.65	3,960	.37	9,936	.83	24,1000	1.74
Telephone (wire and radio)	1,726	.19	3,026	.31	8,050	.75	3,558	.39	8,805	.91	22,000	2.04
Telegraph, misc. comm. services	184	.39	379	.60	700	1.15	261	.55	738	1.16	1,200	1.97
Radio broadcasting, TV	60	.05	126	.07	250	.10	141	.11	393	.22	900	.37
Utilities, sanitary services	1,207	.11	2,042	.16	4,000	.28	2,642	.25	6,865	.55	11,100	.78
Electric light and power	382	.12	807	.19	1,900	.46	937	.29	2,525	.57	3,400	.81
Electric-gas utilities	470	.24	693	.34	1,300	.56	785	.40	1,671	.82	3,300	1.42
Gas, steam supply systems	274	.16	390	.24	550	.33	667	.40	1,354	.81	2,200	1.32
Water supply	38	.03	66	.04	100	.05	193	.15	469	.31	900	.48
Sanitary services	35	.01	74	.02	120	.03	37	.01	793	.28	1,200	.30
Other utilities, n.e.c.	8	.12	12	.17	30	.29	23	.34	53	.75	100	.98
Wholesale and retail trade	9,942	.06	18,782	.09	35,000	.14	16,595	.10	44,455	.22	90,000	.35
Wholesale trade	7,871	.20	14,789	.31	27,540	.51	9,666	.25	24,948	.52	49,000	.92
Wholesale, except misc. wholesale	6,856	.26	13,126	.40	25,600	.68	7,526	.28	19,926	.60	38,500	1.03
Motor vehicles and equipment	190	.06	345	.08	580	.11	1,069	.32	2,792	.65	4,800	.92
Drugs, chemicals allied products	236	.10	397	.14	660	.23	1,088	.47	2,599	.97	4,650	1.59
Dry goods and apparel	157	.10	257	.16	410	.21	394	.25	881	.53	1,700	.88
Food and related products	274	.05	486	.08	760	.11	1,381	.24	3,314	.50	6,300	.88
Farm products—raw materials	45	.04	108	.07	200	.20	135	.13	478	.31	800	.80
Electrical goods	568	.18	992	.26	1,550	.34	888	.28	2,183	.58	4,400	.96
Hardware, plumbing	50	.03	89	.05	140	.06	280	.16	727	.35	1,300	.58
Machinery, equipment, supplies	5,336	.72	10,452	.99	23,140	1.88	2,291	.31	6,952	.66	14,550	1.18
Misc. wholesale trade	1,015	.08	1,663	.11	2,400	.15	2,140	.17	5,022	.34	10,500	.65
Metals and minerals, n.e.c.	166	.13	250	.18	380	.23	231	.17	497	.35	950	.58
Petroleum products	330	.16	595	.24	770	.32	8	–	11	–	15	.01
Scrap and waste material	–	–	–	–	–	–	30	.03	90	.07	235	.20
Alcoholic beverages	33	.03	62	.05	90	.07	270	.27	757	.58	1,500	1.21
Paper and its products	173	.13	265	.20	390	.24	252	.19	527	.40	1,100	.68
Lumber, construction materials	40	.02	60	.03	90	.04	183	.11	430	.24	900	.42
Wholesale trade, n.e.c.	273	.06	461	.08	680	.11	1,166	.25	2,710	.50	5,800	.97
Retail trade	2,071	.01	3,993	.02	7,460	.04	6,929	.06	19,507	.12	41,000	.20
Building materials	48	.01	87	.01	150	.02	204	.03	563	.08	1,100	.14
Lumber, building materials	35	.01	63	.01	110	.02	163	.04	474	.10	910	.19
Hardware and farm equipment	13	.01	24	.01	40	.01	41	.02	89	.04	190	.06
General merchandise, total	1,162	.06	2,138	.08	4,100	.10	3,537	.14	9,363	.32	19,100	.45
Department, mail order	809	.08	1,628	.08	3,360	.11	2,661	.17	7,626	.39	15,720	.53
Limited price stores	98	.03	147	.05	220	.70	205	.07	424	.15	860	.26
Vending machine operators	22	.03	35	.04	50	.04	34	.15	104	.14	280	.21
Direct selling	37	.01	41	.01	50	.01	200	.06	340	.10	440	.13
Misc. merchandise stores	196	.06	287	.09	420	.06	437	.14	867	.29	1,800	.36
Food and dairy stores	184	.01	378	.02	740	.03	1,099	.06	3,006	.13	7,200	.24
Grocery stores	169	.01	343	.02	670	.03	1,007	.06	2,724	.14	6,420	.25
Dairy product stores	5	.01	11	.02	20	.05	26	.07	75	.17	210	.50
Retail bakeries	–	–	–	–	–	–	50	.04	161	.12	460	.30
Food stores, n.e.c.	10	.01	24	.02	50	.03	16	.01	46	.03	110	.07
Auto dealers, gas stations	45	–	73	–	110	–	295	.02	832	.04	1,900	.08
Motor vehicle dealers	18	–	20	–	25	–	176	.02	434	.05	980	.10
Tire, battery, accessory stores	27	.01	53	.02	85	.02	119	.07	398	.15	920	.25
Apparel and accessories	84	.01	144	.01	290	.03	512	.07	1,400	.15	2,900	.26
Apparel, accessory stores	40	.01	98	.01	200	.02	397	.06	1,076	.14	2,220	.25
Shoe stores	24	.01	46	.03	90	.04	115	.08	324	.19	680	.29
Furniture and appliances	85	.01	190	.03	390	.06	278	.05	801	.12	1,800	.22
Home furnishing stores	22	.01	85	.02	150	.03	151	.04	402	.10	900	.18
Appliance, TV, radio stores	63	.03	126	.06	240	.08	127	.06	399	.15	900	.30
Eating and drinking places	100	–	171	–	220	–	296	.01	1,518	.04	3,100	.06

See notes at end of table.

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Computer systems analysts						Computer and peripheral equipment operators					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Eating and drinking places	100	–	171	–	220	–	286	0.01	1,518	0.04	3,100	0.06
Misc. retail trade stores	383	.02	812	.05	1,460	.06	718	.05	2,024	.11	3,900	.16
Drug stores	58	.01	96	.02	140	.02	208	.04	530	.11	1,100	.16
Liquor stores	–	–	–	–	–	–	8	.01	40	.02	80	.04
Farm, garden supply stores	6	.01	18	.01	40	.02	58	.05	198	.12	410	.22
Jewelry stores	17	.02	36	.03	70	.04	44	.04	170	.13	380	.24
Fuel and ice dealers	36	.03	51	.05	75	.07	190	.16	352	.32	640	.62
Retail florists	–	–	–	–	–	–	–	–	–	–	–	–
Misc. retail trade stores	286	.06	612	.09	1,135	.13	220	.05	736	.11	1,290	.15
Finance, insurance, real estate	8,352	.22	14,358	.29	30,100	.46	26,229	.69	69,026	1.37	147,500	2.27
Finance, total	3,949	.25	7,846	.36	18,100	.62	16,038	.99	46,527	2.17	103,000	3.37
Banking	2,933	.30	5,957	.40	15,600	.80	12,452	1.26	36,245	2.72	81,000	4.18
Credit agencies	454	.12	920	.19	2,000	.26	1,821	.51	5,978	1.17	11,500	1.49
Stock brokers, investment	562	.21	969	.30	1,500	.43	1,765	.67	4,304	1.43	9,500	2.75
Insurance	4,261	.31	6,204	.38	10,400	.53	9,751	.72	21,374	1.33	42,500	2.17
Real estate	152	.02	308	.02	600	.04	440	.05	1,125	.09	2,000	.14
Services, total	26,240	.13	59,800	.22	147,500	.42	32,498	.16	103,847	.38	236,000	.67
Hotels and lodging places	93	.01	100	.01	170	.01	130	.01	540	.04	1,400	.07
Hotels and motels	42	–	62	–	125	.01	130	.02	540	.06	1,400	.11
Lodging places, except hotels	51	.02	38	.01	45	.01	–	–	–	–	–	–
Other personal services	48	–	52	–	50	–	110	.01	153	.01	190	.01
Laundry, cleaning	48	.01	52	.01	50	.02	110	.02	153	.03	190	.06
Misc. business services	14,768	.90	33,675	1.26	89,420	2.14	13,208	.81	42,133	1.58	99,560	2.39
Advertising	79	.06	131	.09	260	.18	169	.13	382	.25	740	.50
Business management services	1,404	.77	3,156	1.14	6,900	1.50	1,024	.57	3,402	1.73	8,400	1.82
Commercial R&D	958	1.10	2,211	1.83	5,200	2.29	683	.78	2,137	1.58	6,100	2.69
Computer programming	10,886	9.70	24,840	12.83	66,560	19.49	8,903	7.94	27,219	14.17	61,520	17.09
Detective and protective	7	.01	23	.01	90	.02	111	.08	445	.16	1,300	.28
Employment, temporary help	56	.02	154	.04	510	.08	–	–	–	–	–	–
Services to buildings	–	–	–	–	–	–	–	–	–	–	–	–
Other misc. services	1,376	.29	3,360	.43	9,900	.93	2,318	.49	8,548	.109	21,500	2.01
Automobile repair services	109	.02	202	.02	420	.05	157	.03	494	.07	1,100	.12
Auto repair	–	–	–	–	–	–	35	.01	162	.03	390	.07
Auto services, except repair	109	.06	202	.10	420	.14	122	.07	332	.15	710	.24
Other repair services	–	–	–	–	–	–	–	–	–	–	–	–
Electrical repair shops	–	–	–	–	–	–	–	–	–	–	–	–
Other repair services	–	–	–	–	–	–	–	–	–	–	–	–
Motion pictures, theaters	89	.04	93	.04	150	.05	182	07	289	.14	510	.17
Misc. entertainment	5	–	10	–	20	–	69	.02	347	.04	690	.08
Medical, other health	1,345	.02	3,307	.05	8,800	.08	3,174	.07	10,809	.16	28,500	.26
Hospitals	1,014	.04	2,518	.07	7,250	.12	2,866	.10	9,187	.24	24,470	.42
Convalescent institutions	38	.01	124	.01	650	.03	33	.01	209	.03	630	.03
Health services, n.e.c.	293	.10	665	.10	1,700	.18	275	.10	1,413	.21	3,400	.36
Legal services	5	–	10	–	20	–	26	.01	134	.02	360	.05
Educational services	3,579	.06	7,292	.10	15,200	.19	7,701	.13	22,147	.29	44,500	.55
Elementary, secondary	478	.01	1,152	.02	2,600	.05	970	.02	3,002	.06	4,300	.08
Colleges and universities	2,720	.17	5,290	.26	10,710	.47	6,205	.39	17,429	.86	35,450	1.57
Libraries	23	.03	66	.06	190	.13	34	.04	205	.20	650	.43
Educational services, n.e.c.	358	.14	784	.22	1,700	.34	492	.20	1,511	.41	4,100	.83
Museums, art galleries, zoos	5	.02	14	.03	50	.05	18	.06	66	.13	190	.21
Nonprofit organizations	555	.04	1,087	.06	2,200	.11	1,162	.06	3,247	.17	6,500	.26
Religious organizations	–	–	–	–	–	–	128	.02	375	.05	510	.06
Welfare services	364	.08	706	.11	1,450	.16	453	.11	1,236	.19	2,450	.26
Nonprofit membership organizations	191	.06	381	.08	750	.12	581	.15	1,636	.33	3,540	.59
Other professional, related services	5,639	.88	13,958	1.07	31,200	1.91	6,581	.80	23,288	1.80	52,500	3.21
Engineering and architectural services	761	.24	2,121	.43	4,500	.72	602	.19	2,382	.48	5,900	.94
Accounting, auditing	3,847	1.29	9,387	2.12	22,000	3.67	5,139	1.72	18,380	4.15	39,900	6.65
Misc. professional services	1,031	.50	2,450	.68	4,700	1.09	840	.41	2,526	.70	6,700	1.55
Government, total	13,547	.32	21,914	.43	42,000	.71	14,684	.34	37,340	.74	89,200	1.50
Federal public administration	10,446	.46	15,094	.66	23,500	.99	9,432	.42	20,664	.91	42,000	1.76
Postal service	143	.02	339	.05	1,000	.15	213	.03	754	.11	2,000	.30
Other Federal public administration	10,333	.87	14,755	.93	22,500	1.31	9,219	.59	19,910	1.25	40,000	2.32
State public administration	1,989	.32	4,408	.49	11,000	.97	3,157	.51	10,135	1.12	29,000	2.56
Local public administration	1,112	.08	2,412	.13	7,500	.31	2,095	.16	6,541	.35	18,200	.75

See notes at end of table.

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Keypunch operators						Computer service technicians					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Total, all industries	299,986	0.38	272,983	0.29	230,000	0.20	35,999	0.05	63,001	0.07	160,000	0.14
Agriculture, forestry, fisheries	393	.01	423	.01	350	.01	5	–	5	–	10	–
Agriculture	270	.01	264	.01	200	.01	5	–	5	–	10	–
Agricultural production	119	–	100	–	80	–	–	–	–	–	–	–
Services, except horticulture	131	.08	122	.06	100	.03	–	–	–	–	–	–
Horticultural services	20	.01	32	.01	20	.01	5	–	5	–	10	–
Forestry	123	.23	159	.21	150	.21	–	–	–	–	–	–
Fisheries	–	–	–	–	–	–	–	–	–	–	–	–
Mining	1,718	.27	2,083	.24	1,700	.16	41	.01	87	.01	210	.02
Metal mining	198	.21	169	.18	150	.13	6	.01	7	.01	25	.02
Coal mining	75	.06	93	.04	50	.01	–	–	–	–	–	–
Crude petroleum and natural gas	1,307	.47	1,713	.38	1,400	.29	35	.01	80	.02	185	.04
Nonmetallic mining, quarrying	138	.12	118	.10	100	.09	–	–	–	–	–	–
Construction	2,818	.06	2,673	.04	2,100	.03	95	–	95	–	200	–
General building contractors	397	.03	388	.03	300	.02	17	–	16	–	25	–
General contractors, exc. building	1,985	.14	1,776	.11	1,450	.08	23	–	20	–	35	–
Special trade contractors	443	.02	430	.01	350	.01	55	–	59	–	140	–
Manufacturing	83,019	.42	66,518	.32	47,900	.20	10,796	.06	15,914	.08	41,000	.17
Durable goods	50,436	.44	41,743	.34	33,000	.23	10,370	.09	15,349	.12	39,700	.27
Ordnance	1,492	.50	730	.42	400	.23	130	.04	104	.06	200	.12
Lumber and wood products	675	.11	505	.07	350	.05	5	–	4	–	10	–
Logging	32	.83	26	.02	20	.02	–	–	–	–	–	–
Sawmills, planing mills	485	.12	356	.08	240	.05	5	–	4	–	10	–
Misc. wood products	158	.13	123	.09	90	.05	–	–	–	–	–	–
Furniture and fixtures	1,180	.26	1,011	.19	850	.13	27	.01	42	.01	90	.01
Stone, clay, and glass products	1,617	.25	1,226	.18	900	.13	6	–	6	–	10	–
Glass and glass products	586	.31	399	.20	280	.12	6	–	6	–	10	–
Cement, concrete, plaster	459	.21	367	.15	240	.09	–	–	–	–	–	–
Structural clay products	109	.18	69	.13	50	.16	–	–	–	–	–	–
Pottery and related products	97	.22	75	.16	60	.14	–	–	–	–	–	–
Misc. nonmetallic stone	387	.29	325	.21	280	.19	–	–	–	–	–	–
Primary metal industries	5,107	.39	3,910	.31	2,700	.20	103	.01	117	.01	200	.01
Blast furnaces, steel works	2,530	.46	1,802	.37	1,200	.25	69	.01	78	.02	130	.03
Other primary steel	935	.25	687	.19	470	.11	22	.01	30	.01	50	.01
Primary aluminum	607	.39	570	.32	480	.26	6	–	5	–	10	.01
Other primary nonferrous	1,036	.46	851	.37	550	.21	6	–	4	–	10	–
Fabricated metal products	4,646	.35	4,125	.27	3,300	.18	21	–	20	–	40	–
Cutlery, other hardware	944	.62	823	.46	710	.31	–	–	–	–	–	–
Fabricated metal products	1,307	.30	1,097	.22	780	.11	21	–	20	–	40	.01
Screw machine products	493	.47	395	.36	270	.24	–	–	–	–	–	–
Metal stamping	611	.26	569	.23	490	.17	–	–	–	–	–	–
Misc. metal products	1,491	.32	1,241	.24	1,050	.19	–	–	–	–	–	–
Machinery, except electrical	10,337	.52	9,888	.42	8,600	.29	8,079	.41	12,323	.53	33,890	1.14
Engines and turbines	622	.57	592	.45	520	.36	12	.01	19	.01	50	.04
Farm machinery, equipment	946	.74	812	.54	650	.36	19	.01	27	.02	60	.03
Construction machinery	1,616	.56	1,694	.46	1,540	.33	29	.01	64	.02	150	.03
Metalworking machinery	1,221	.38	1,124	.32	980	.22	48	.02	74	.02	140	.03
Office, accounting machinery	794	.87	479	.66	320	.49	1,125	1.24	1,042	1.45	1,350	2.05
Electronic computing equipment	1,839	.87	1,523	.57	1,410	.30	6,696	3.56	10,842	4.05	31,650	6.73
Machinery, n.e.c.	3,499	.41	3,464	.36	3,200	.26	148	.02	255	.03	490	.04
Electrical machinery	11,140	.58	9,306	.45	7,300	.29	1,306	.07	1,837	.09	3,600	.14
Household appliances	875	.47	652	.36	480	.23	10	.01	14	.01	20	.01
Radio, TV, communications equipment	4,548	.72	3,458	.58	2,400	.37	816	.10	782	.13	1,400	.21
Electrical machinery, n.e.c.	5,717	.52	5,195	.41	4,420	.27	480	.06	1,041	.08	2,180	.13
Transportation equipment	9,209	.48	8,973	.34	5,100	.22	393	.02	436	.02	750	.03
Motor vehicle equipment	3,925	.49	3,823	.37	3,100	.27	46	.01	76	.01	130	.01
Aircraft and parts	4,194	.83	2,463	.42	1,350	.26	276	.04	302	.06	520	.10
Ship, boat building, repair	730	.26	516	.18	310	.10	71	.03	58	.02	100	.03
Railroad equipment	212	.42	203	.33	180	.28	–	–	–	–	–	–
Mobile dwellings	59	.07	57	.06	50	.02	–	–	–	–	–	–
Cycles, misc. transportation equipment	89	.35	111	.26	110	.17	–	–	–	–	–	–
Professional and scientific instruments	2,894	.84	2,743	.49	2,400	.35	268	.06	404	.07	800	.12
Scientific instruments	1,001	.56	849	.43	690	.35	192	.11	268	.14	550	.28
Optical, health service supplies	842	.82	1,009	.49	960	.36	38	.03	76	.04	130	.05
Photo equipment and supplies	888	.80	765	.58	660	.36	38	.03	60	.06	120	.07
Watches and clock devices	183	.56	120	.40	90	.25	–	–	–	–	–	–
Misc. manufacturing	1,938	.44	1,528	.33	1,100	.22	32	.01	56	.01	110	.02
Nondurable goods	32,584	.40	23,775	.29	14,900	.16	426	.01	565	.01	1,300	.01
Food and kindred products	5,458	.31	3,851	.23	2,240	.13	80	–	106	.01	240	.01
Meat products	1,049	.30	806	.23	520	.15	7	–	5	–	10	–
Dairy products	851	.35	505	.27	210	.15	9	–	5	–	10	.01
Canning and preserving	729	.26	572	.19	370	.10	30	.01	54	.02	140	.04
Grainmill products	400	.29	292	.20	160	.10	–	–	–	–	–	–
Bakery products	564	.20	372	.16	180	.09	–	–	–	–	–	–
Confectionery products	380	.42	216	.28	110	.14	–	–	–	–	–	–
Beverages	707	.30	473	.21	210	.09	18	.01	22	.01	40	.02
Misc. food preparations	818	.45	615	.33	380	.19	16	.01	19	.01	40	.02
Tobacco manufacturing	307	.38	181	.27	100	.17	–	–	–	–	–	–
Textile mill products	3,464	.35	2,449	.27	1,450	.14	21	–	20	–	50	–
Knitting mills	970	.39	738	.31	420	.13	–	–	–	–	–	–
Dyeing, finishing textiles	298	.36	196	.26	110	.14	7	.01	9	.01	25	.03
Floor coverings	408	.71	301	.49	200	.19	–	–	–	–	–	–
Yarn, fabric mills	1,493	.29	1,002	.22	690	.13	14	–	11	–	25	.01
Misc. textile mill products	297	.40	212	.30	130	.16	–	–	–	–	–	–
Apparel, textile products	3,772	.27	2,814	.21	1,750	.11	8	–	6	–	10	–
Apparel and accessories	3,317	.27	2,482	.21	1,500	.11	–	–	–	–	–	–
Misc. fabricated products	455	.27	332	.18	250	.11	8	–	6	–	10	–
Paper and allied products	2,711	.38	1,841	.26	1,100	.14	160	.02	219	.03	490	.06
Pulp, paper, paperboard mills	1,232	.42	793	.30	430	.17	5	–	3	–	10	–
Paperboard containers, boxes	583	.26	359	.17	240	.09	–	–	–	–	–	–
Misc. paper and pulp products	896	.47	689	.32	430	.16	155	.08	215	.10	480	.18

See notes at end of table.

41

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Keypunch operators						Computer Service Technicians					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Printing and publishing	5,997	0.52	4,260	0.34	2,600	0.19	77	0.01	120	0.01	300	0.02
Newspaper publishing, printing	930	.22	693	.15	500	.09	24	.01	50	.01	140	.03
Printing, publishing, exc. newspaper	5,067	.68	3,567	.44	2,100	.26	53	.01	70	.01	160	.02
Chemical and allied products	5,389	.52	4,174	.39	3,000	.23	43	–	49	–	110	.01
Industrial chemicals	1,407	.44	1,032	.32	630	.16	22	.01	23	.01	60	.01
Plastics, synthetics	311	.31	211	.22	130	.12	7	.01	8	.01	20	.02
Synthetic fibers	528	.49	404	.35	300	.17	–	–	–	–	–	–
Drugs and medicines	1,009	.71	908	.49	780	.35	–	–	–	–	–	–
Soaps and cosmetics	1,021	.82	828	.62	810	.37	8	.01	11	.01	30	.02
Paints and varnishes	569	.82	424	.59	300	.33	–	–	–	–	–	–
Agricultural chemicals	221	.40	171	.28	130	.23	6	.01	7	.01	10	.02
Misc. chemicals	313	.28	198	.23	120	.11	–	–	–	–	–	–
Petroleum and coal products	1,778	.94	1,358	.67	900	.51	15	.01	23	.01	50	.03
Petroleum refining	1,564	1.02	1,206	.73	800	.66	15	.01	23	.01	90	.04
Misc. petroleum, coal products	214	.58	182	.41	100	.18	–	–	–	–	–	–
Rubber, misc. plastic products	2,628	.46	2,146	.29	1,500	.19	18	–	16	–	30	–
Rubber products	1,758	.61	1,279	.43	720	.21	5	–	3	–	10	–
Misc. plastic products	870	.30	867	.19	780	.17	10	–	13	–	20	–
Leather products	1,100	.34	882	.26	360	.17	7	–	8	–	20	.01
Leather tanning, finishing	74	.28	42	.19	30	.22	–	–	–	–	–	–
Footwear, except rubber	780	.35	483	.28	240	.18	–	–	–	–	–	–
All other leather products	246	.38	157	.25	90	.13	7	.01	8	.01	20	.03
Transportation, other public utilities	23,113	.46	17,972	.31	12,550	.20	526	.01	816	.01	1,580	.02
Transportation, total	11,091	.39	8,039	.24	5,250	.16	101	–	135	–	230	.01
Railroads, railway express	5,304	.88	2,993	.58	1,500	.35	33	.01	40	.01	75	.02
Local, interurban transit	310	.08	178	.04	100	.02	5	–	4	–	5	–
Street railways, bus lines	294	.10	158	.05	90	.02	5	–	4	–	5	–
Taxicab, service	16	.02	20	.02	10	.01	–	–	–	–	–	–
Trucking and warehousing	2,769	.24	2,383	.16	1,800	.12	5	–	7	–	10	–
Trucking services	2,463	.23	2,171	.16	1,650	.11	–	–	–	–	–	–
Warehousing and storage	306	.35	212	.23	150	.14	5	.01	7	.01	10	.01
Water transportation	582	.25	424	.17	270	.13	–	–	–	–	–	–
Air transportation	1,479	.43	1,287	.31	1,050	.20	51	.01	76	.02	130	.02
Pipelines	114	.87	100	.52	80	.50	7	.04	8	.04	10	.06
Transportation services	533	.50	674	.40	450	.18	–	–	–	–	–	–
Communications, utilities, sanitary services	12,022	.56	9,933	.40	7,300	.26	425	.02	681	.03	1,380	.05
Communications	6,887	.82	5,284	.44	3,800	.27	369	.03	613	.05	1,225	.09
Telephone (wire and radio)	6,241	.89	4,880	.51	3,440	.32	248	.03	401	.04	950	.09
Telegraph, misc. comm. services	171	.36	173	.27	160	.26	112	.24	196	.31	250	.41
Radio broadcasting, TV	275	.21	231	.13	200	.08	9	.01	16	.01	25	.01
Utilities, sanitary services	5,336	.50	4,649	.37	3,500	.25	56	.01	68	.01	125	.01
Electric light and power	1,915	.59	1,979	.45	1,800	.43	45	.01	59	.01	105	.03
Electric—gas utilities	1,902	.97	1,490	.73	900	.39	5	–	4	–	10	–
Gas, steam supply systems	1,049	.83	783	.47	485	.28	6	–	5	–	10	.01
Water supply	386	.29	340	.22	300	.16	–	–	–	–	–	–
Sanitary services	52	.02	46	.02	30	.01	–	–	–	–	–	–
Other utilities, n.e.c.	31	.46	11	.15	5	.05	–	–	–	–	–	–
Wholesale and retail trade	42,579	.26	40,282	.20	36,000	.14	10,471	.06	18,737	.09	46,000	.18
Wholesale trade	25,446	.65	23,253	.48	20,000	.37	10,060	.26	17,981	.37	44,100	.82
Wholesale, except misc. wholesale	18,279	.89	16,549	.50	14,000	.37	9,638	.36	17,288	.52	42,750	1.14
Motor vehicles and equipment	2,507	.75	2,494	.58	2,350	.45	–	–	–	–	–	–
Drugs, chemicals allied products	3,004	1.29	2,415	.90	1,850	.57	8	–	7	–	10	–
Dry goods and apparel	1,190	.76	937	.56	810	.42	–	–	–	–	–	–
Food and related products	3,391	.58	2,796	.42	2,050	.29	16	–	16	–	20	–
Farm products—raw materials	336	.32	344	.22	320	.32	–	–	–	–	–	–
Electrical goods	2,368	.75	2,153	.57	1,800	.39	278	.09	435	.12	970	.21
Hardware, plumbing	1,165	.88	937	.45	820	.37	–	–	–	–	–	–
Machinery, equipment, supplies	4,319	.58	4,473	.42	4,200	.34	9,336	1.26	16,830	.159	43,100	3.51
Misc. wholesale trade	7,167	.55	6,704	.45	6,000	.37	422	.03	673	.05	1,350	.08
Metals and minerals, n.e.c.	773	.58	678	.48	625	.38	22	.02	48	.03	110	.07
Petroleum products	1,526	.76	1,311	.56	1,100	.46	12	.01	18	.01	30	.01
Scrap and waste material	37	.04	39	.03	30	.03	–	–	–	–	–	–
Alcoholic beverages	924	.94	1,028	.79	900	.72	7	.01	12	.01	20	.02
Paper and its products	755	.57	618	.47	550	.34	19	.01	23	.02	30	.02
Lumber, construction materials	393	.24	366	.20	300	.14	–	–	–	–	–	–
Wholesale trade, n.e.c.	2,757	.59	2,675	.49	2,500	.42	362	.08	572	.11	1,160	.19
Retail trade	17,133	.14	17,029	.11	16,000	.08	411	–	776	–	1,900	.01
Building materials	536	.09	446	.06	390	.05	–	–	–	–	–	–
Lumber, building materials	264	.07	245	.05	230	.05	–	–	–	–	–	–
Hardware and farm equipment	272	.12	201	.08	160	.06	–	–	–	–	–	–
General merchandise, total	8,882	.35	8,407	.29	8,020	.19	–	–	–	–	–	–
Department, mail order	6,877	.44	6,989	.36	6,985	.23	–	–	–	–	–	–
Limited price stores	803	.19	386	.14	280	.08	–	–	–	–	–	–
Vending machine operators	192	.28	160	.21	125	.10	–	–	–	–	–	–
Direct selling	319	.10	236	.07	160	.05	–	–	–	–	–	–
Misc. merchandise stores	891	.29	634	.21	490	.10	–	–	–	–	–	–
Food and dairy stores	2,237	.11	2,436	.10	2,210	.07	–	–	–	–	–	–
Grocery stores	2,048	.12	2,210	.11	2,020	.08	–	–	–	–	–	–
Dairy product stores	81	.22	114	.25	90	.22	–	–	–	–	–	–
Retail bakeries	57	.05	57	.04	50	.03	–	–	–	–	–	–
Food stores, n.e.c.	51	.04	55	.04	50	.03	–	–	–	–	–	–
Auto dealers, gas stations	830	.05	944	.05	860	.04	33	–	30	–	40	–
Motor vehicle dealers	463	.06	489	.06	425	.04	23	–	21	–	30	–
Tire, battery, accessory stores	333	.18	404	.15	375	.10	5	–	5	–	5	–
Apparel and accessories	1,436	.19	1,467	.16	1,440	.13	–	–	–	–	–	–
Apparel, accessory stores	1,071	.17	1,126	.15	1,120	.13	–	–	–	–	–	–
Shoe stores	366	.24	341	.20	320	.14	–	–	–	–	–	–
Furniture and appliances	738	.13	724	.11	700	.09	66	.01	121	.02	300	.04
Home furnishing stores	399	.12	353	.09	330	.07	–	–	–	–	–	–
Appliance, TV, radio stores	339	.16	371	.14	370	.12	66	.03	121	.04	300	.10
Eating and drinking places	619	.02	881	.02	740	.01	–	–	–	–	–	–

See notes at end of table.

Table B-1. Continued—Industry distribution of computer employment by occupation, 1970, 1978, and projected 1990

Industry	Keypunch operators						Computer service technicians					
	1970		1978		1990		1970		1978		1990	
	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment	Employment	Percent of industry employment
Retail Trade—Continued												
Misc. retail trade stores	1,855	0.13	1,724	0.09	1,860	0.07	312	0.02	625	0.03	1,560	0.07
Drug stores	588	.13	488	.09	410	.06	–	–	–	–	–	–
Liquor stores	83	.07	88	.06	80	.04	–	–	–	–	–	–
Farm, garden supply stores	122	.10	147	.09	150	.06	–	–	–	–	–	–
Jewelry stores	162	.15	148	.11	140	.09	–	–	–	–	–	–
Fuel and ice dealers	305	.28	196	.18	120	.12	6	.01	7	.01	10	.01
Retail florists	12	.01	16	.01	20	.01	–	–	–	–	–	–
Misc. retail trade stores	583	.13	664	.10	720	.08	306	.07	618	.09	1,550	.18
Finance, insurance, real estate	48,564	1.27	42,287	.84	37,000	.57	283	.01	527	.01	1,300	.02
Finance, total	23,592	1.46	22,815	1.06	21,500	.70	178	.01	386	.02	980	.03
Banking	17,676	1.78	16,906	1.27	16,400	.85	159	.02	341	.03	890	.06
Credit agencies	2,876	.80	3,173	.62	3,000	.39	–	–	–	–	–	–
Stock brokers, investment	3,036	1.15	2,534	.84	2,100	.61	19	.01	44	.01	100	.03
Insurance	24,026	1.78	18,783	1.17	14,600	.74	105	.01	142	.01	280	.01
Real estate	948	.11	909	.07	900	.06	–	–	–	–	–	–
Services, total	63,038	.31	70,814	.26	66,400	.19	12,687	.06	25,132	.09	66,000	.18
Hotels and lodging places	363	.04	377	.03	370	.02	3	–	2	–	10	–
Hotels and motels	312	.04	354	.04	350	.03	3	–	2	–	10	–
Lodging places, except hotels	51	.02	23	.01	20	–	–	–	–	–	–	–
Other personal services	595	.04	337	.02	320	.02	5	–	3	–	10	–
Laundry, cleaning	590	.10	328	.07	320	.10	5	–	3	–	10	–
Misc. business services	27,718	1.69	32,490	1.22	30,200	.72	8,497	.52	17,249	.65	45,130	1.08
Advertising	388	.30	289	.19	190	.13	4	–	3	–	10	.01
Business management services	2,149	1.20	2,407	.87	2,350	.51	334	.19	698	.25	1,800	.39
Commercial R&D	511	.58	538	.40	470	.21	80	.09	148	.11	360	.16
Computer programming	12,983	11.55	13,852	7.21	12,900	3.58	6,541	5.83	12,851	6.69	34,940	9.71
Detective and protective	192	.14	257	.09	240	.05	15	.01	31	.01	70	.01
Employment, temporary help	6,382	2.98	8,818	2.23	8,300	1.32	–	–	–	–	–	–
Services to buildings	–	–	–	–	–	–	36	.01	68	.01	150	.02
Other misc. services	5,153	1.09	6,529	.83	5,750	.54	1,487	.31	3,450	.44	7,800	.73
Automobile repair services	409	.06	385	.05	380	.04	–	–	–	–	–	–
Auto repair	4	–	4	–	–	–	–	–	–	–	–	–
Auto services, except repair	405	.24	381	.18	380	.12	–	–	–	–	–	–
Other repair services	–	–	–	–	–	–	2,128	.67	4,244	.94	12,700	2.57
Electrical repair shops	–	–	–	–	–	–	993	.79	1,339	1.02	4,200	2.29
Other repair services	–	–	–	–	–	–	1,135	.69	2,905	.91	8,500	2.74
Motion pictures, theaters	414	.17	259	.13	190	.06	8	–	5	–	10	–
Misc. entertainment	173	.04	263	.03	230	.03	–	–	–	–	–	–
Medical, other health	6,512	.14	7,585	.11	7,300	.07	28	–	28	–	70	–
Hospitals	5,614	.19	6,000	.15	5,930	.10	28	–	28	–	70	–
Convalescent institutions	58	.01	102	.01	120	.01	–	–	–	–	–	–
Health services, n.e.c.	840	.31	1,483	.22	1,250	.13	–	–	–	–	–	–
Legal services	140	.04	167	.03	150	.02	–	–	–	–	–	–
Educational services	10,594	.18	10,532	.14	9,820	.12	288	–	382	.01	520	.01
Elementary, secondary	1,943	.05	1,799	.04	1,510	.03	22	–	23	–	20	–
Colleges and universities	7,344	.47	7,343	.36	6,780	.30	191	.01	246	.01	280	.01
Libraries	49	.06	40	.04	30	.02	–	–	–	–	–	–
Educational services, n.e.c.	1,258	.50	1,350	.37	1,300	.26	55	.02	113	.03	220	.04
Museums, art galleries, zoos	8	.03	9	.02	10	.01	–	–	–	–	–	–
Nonprofit organizations	3,662	.26	3,702	.19	3,700	.16	53	–	85	–	150	.01
Religious organizations	459	.08	549	.08	560	.07	–	–	–	–	–	–
Welfare services	1,591	.37	1,565	.24	1,550	.17	6	–	8	–	20	–
Nonprofit membership organizations	1,582	.41	1,575	.32	1,570	.26	47	.01	77	.02	130	–
Other professional, related services	12,460	1.51	14,718	1.14	13,950	.85	1,897	.21	3,134	.24	7,400	.45
Engineering and architectural services	669	.21	893	.18	820	.13	121	.04	311	.06	890	.14
Accounting, auditing	10,715	3.58	12,451	2.81	11,870	1.98	1,490	.50	2,679	.60	6,230	1.04
Misc. professional services	1,076	.52	1,374	.38	1,260	.29	86	.04	144	.04	280	.06
Government, total	34,757	.82	31,031	.62	26,000	.44	1,095	.03	1,688	.03	3,700	.06
Federal public administration	18,849	.83	15,660	.69	12,000	.50	1,039	.05	1,624	.07	3,575	.15
Postal service	213	.03	268	.04	200	.03	–	–	–	–	–	–
Other Federal public administration	18,636	1.20	15,394	.97	11,800	.68	1,039	.07	1,624	.10	3,575	.21
State public administration	10,161	1.85	9,912	1.10	9,000	.79	12	–	15	–	25	–
Local public administration	5,747	.42	5,459	.30	5,000	.21	44	–	49	–	100	–

n.e.c. = not elsewhere classified.

NOTE: A dash denotes zero or less than 0.005 percent.

Appendix C. Census Occupational Titles

The 1970 Census of Population lists national totals for computer occupations in six categories. The six categories are designated as follows: Computer Programmer, Computer Systems Analysts, Computer Specialists, n.e.c., Computer Peripheral Equipment Operators, Keypunch Operators, and Data Processing Machine Repairers. The BLS industry- occupational matrix has adopted exactly these census computer occupational categories. However, for purposes of this BLS computer study, two of these common census and matrix occupational categories have been combined. Data for computer specialists, n.e.c., are combined with "systems analysts" because the occupational titles that comprise the "computer specialist, n.e.c.," category seem overwhelmingly to involve systems analysis functions. The job titles included in each of these six categories are as follows:

Computer Programmers
- computer programmer
- digital-computer programmer
- electronic data programmer
- programmer, computer
- Univac-programmer

Computer Systems Analysts
- computer analyst
- computer-systems planning
- computing-systems analyst
- data-processing-systems analyst
- digital-computer-systems analyst
- engineer, systems
- health-systems analyst, computer
- manager, computer programming
- systems analyst, computer systems
- systems analyst, data processing

Computer Specialists, n.e.c.
- computer scientist
- data-processing systems-project planner
- engineer, computer application
- methods analyst, computer
- software specialist

Computer and Peripheral Equipment Operators
- card-tape-converter operator
- computer-console operator
- computer operator
- computing-machine operator
- console operator, clerical
- digital-computer operator
- high-speed-printer operator
- K.S.T. operator
- key station terminal operator
- peripheral-equipment operator
- tape-to-card-converter operator

Keypunch Operators
- card puncher
- card-punching-machine operator
- encoder
- encoder clerk
- I.B.M. machine operator
- I.B.M. operator
- I.B.M. puncher
- I.B.M. supervisor
- I.B.M. verifier
- key puncher
- keypunch operator
- punch-card operator
- punch operator, office machine
- verifying machine operator

Data Processing Machine Repairers
- computer's service man—
  - data-processing-machine rental
- data-processing-machine serviceman
- engineer, customer's
- I.B.M. installer
- mechanic:
  - computing systems
  - data processing
  - electronic computer
  - I.B.M. machine

Appendix D. Glossary of Computer Terms

ADP—Automatic data processing.

ALGOL—A higher level programming language used for scientific applications.

Alphanumeric—A set of characters that includes letters, numbers, and special symbols such as punctuation or mathematical notations.

Analog computer—A computer that operates on data represented by measurable physical quantities (speed, temperature, voltage, etc).

Applications programming—Development of programs to meet specific user needs, such as inventory control, payroll, and reservations systems.

Assembler—A computer program that converts the user's instructions written in alphanumerics into a form that the machine can understand.

Automation—The development and application of methods of making a process self-moving or self-controlling.

Auxiliary storage—Any device that supplements the main storage area of a computer.

BASIC (Beginners All-Purpose Symbolic Instruction Code)—A programming language that is relatively easy to learn and can be used for a variety of applications.

Batch processing—A method that uses one program to process accumulations (batches) of similar data.

Binary—A numbering system based on 2's rather than 10's. Only the digits 0 and 1 are used.

Bit—A binary digit (0 or 1).

Byte—A sequence of eight binary digits usually operated upon as a unit.

Canned (packaged) programs—Programs prepared for users in machine-readable form by vendors or software firms to meet specific applications.

Card punch—A machine that encodes data onto tabulating cards in patterns of round or rectangular holes. Card punches may be activated by computer or from a keyboard.

Card reader—A machine that transcribes data from punched cards to main computer storage or auxiliary storage devices.

Centralized data processing—Data processing organization in which the user places all computing power at one site.

Character—One of a set of elements that may be arranged in ordered groups to express information. Each character has two forms: 1) A form that can be read by humans—the graphic, including the decimal digits 0-9, the letters A-Z, punctuation marks, and other formatting and control symbols; 2) a form that can be read by computers—the code, consisting of a group of binary bits.

COBOL (Common Business Oriented Language)—A higher level programming language designed for business applications.

Coding—Preparing a set of computer instructions from a detailed flow chart to perform a given action or solve a given problem.

COM (Computer Output on Microfilm)—An auxiliary computer device that produces microfilm records from computer-generated data.

Compiler—A computer program that converts a higher level language into a machine language program.

Computer—A device capable of accepting a series of logical operations, applying prescribed processes to the sequence, and supplying the results of these processes.

Computer, off-line—A computer not actively monitoring or controlling a process.

Computer, on-line—A computer actively monitoring or controlling a process.

Console—The part of a computer used for manual control and observation of the computer system.

Core storage—The main storage area of a computer containing arrays of magnetic cores, which hold instructions and/or data to be processed.

CPU (Central processing unit)—That portion of a computer containing the arithmetic, logic, control, and, in some cases, main storage devices.

CRT (Cathode ray tube)—A device similar to a television screen upon which data can be stored or displayed.

Data—Basic elements of information—facts, numbers, letters, symbols—that can be processed by a computer.

Data collection—The act of bringing data from one or more locations to a central location.

Data communications—Movement of data from one point to another by electrical transmission systems.

Data processing—A series of planned actions and operations upon data to achieve a desired result.

DDP (Distributed data processing)—Data processing organization that gives computing power to the person who can immediately and most efficiently use the information.

Debugging—The process of determining the correctness of a computer routine, locating any errors, and correcting them. Also, the detection and correction of malfunctions in the computer itself.

Digital computer—A computer that solves problems by using coded numbers to express all quantities and variables.

Downtime—The time interval during which a device is not working properly.

EDP (Electronic Data Processing)—Equipment that processes data by electronic means; e.g., analog or digital computers.

EFTS (Electronic Funds Transfer System)—Method of handling monetary transactions, such as bank deposits and bill payments, using computers and other electronic equipment instead of paper.

External memory—A storage facility or device, such as magnetic tape, which is not an integral part of a computer.

File—A collection of related records; e.g., a complete set of invoices in an invoice file.

Firmware—A set of functions built into the computer hardware that would otherwise be handled by software or special purpose logic.

FORTRAN (Formula translator)—a higher level programming language designed for mathematical, scientific, and engineering applications.

General-purpose computers—Computers that are primarily character or byte-oriented and programmed in higher level languages.

Generation—A stage of technological advance in computers. First-generation computers were characterized by their use of vacuum tubes; second generation, by transistors; and third generation, by integrated circuits.

Hard copy—Printed copy of machine output; e.g., reports, tables, listings, documents, and other business forms.

Hardware—The actual equipment used in a computer system, including peripheral equipment such as printers and tape drives, as well as the computer itself.

High speed printer—Computer output printer that prints all of the characters on a line simultaneously.

Higher level language—Programming language designed for a specific range of applications and relative ease of use.

Input—Information representing data to be processed and instructions to control processing, which is moved into the internal storage of a data processing system.

Instruction—A coded statement or command that causes a data processing system to carry out an operation.

Interface—The interconnection between two pieces of hardware or two systems that have different functions.

Internal storage—Memory devices, such as magnetic cores, forming an integral physical part of a computer and directly controlled by the central processing unit.

Key-to-disk, key-to-tape systems—Systems for entering data directly onto a disk or tape by typing at a keyboard.

Keypunch—A keyboard-operated device that punches holes in a card to represent data.

Key verifier—A device, similar to the keypunch, used to make sure that data have been correctly punched into cards.

Line printer—A printing device that accepts information directly from a computer and prints one line at a time.

Machine language—Language that can be understood and interpreted directly by a computer.

Magnetic disk—A flat, circular plate with a surface that can be magnetized to store data.

Magnetic ink—Ink that contains particles of iron oxide, which can be detected (read) by machine sensors.

Magnetic tape—Tape with a ferrous oxide surface upon which data can be stored.

Main storage—The general-purpose storage area of a computer (same as internal storage).

Memory—A device or medium used to store information in a form that can be understood by the computer hardware.

MICR (Magnetic Ink Character Recognition)—Machine recognition of characters printed on a document with magnetic ink.

Microfiche—Sheet of film used for displaying computer output using a small amount of storage space.

Microfilm—Photographic filmstrip used for retaining records of printed document while utilizing a small amount of storage space.

Minicomputer—Small, general-purpose computers that are part of a family that has at least one product in the $2,000-$25,000 price range and comes with at least 4K

RAM. Size classes are Supermini, Traditional Mini, and Micro-mini.

Multiprocessor—A computer system incorporating multiple arithmetic and logic units for simultaneous use.

Multiprogramming—A technique for handling numerous routines or programs seemingly simultaneously by overlapping or interleaving their execution; that is, by permitting more than one program to time-share machine components.

Numeric—A machine alphabet that includes only numerals, in contrast to alphanumeric, which has both letters and numerals.

OCR (Optical Character Reader)—An information processing device that accepts prepared forms and converts data from them to computer output media via optical character recognition.

Off-line—Pertains to equipment or devices not in direct communication with the central processing unit of a computer.

On-line—Pertains to equipment or devices directly connected to the central processing unit.

Operating system—A program that controls the overall execution of computer programs. It is available to the computer at all times, either in internal storage or on auxiliary storage.

Operations research—Application of scientific principles to business management. This may involve setting up mathematical equations to depict business problems.

Original equipment manufacturer—A company that purchases computer hardware for use as components in the systems that it sells.

Output—Processed information recorded on a medium such as a business form or magnetic tape.

Peripheral equipment—Any equipment other than the central processing unit of a computer, such as a printer, card reader, terminal, or tape drive that provides outside communication to the system.

PL/1—Higher level programming language with a wide variety of features and applications.

Printer—A device for writing out computer results as numbers, words, or symbols.

Process control computer—A computer that controls a production process, such as steelmaking, petroleum refining, or electric power generation.

Processor—The hardware or software capable of performing or directing the performance of many functions.

Program (noun)—A plan for the solution of a problem. A complete program includes plans for the transcription of data, coding for the computer, and plans for the absorption of the results into the system. The list of coded instructions is called a routine.

Program (verb)—To plan a computation or process from asking a question to delivering the results, including the integration of the operation into an existing system. Thus, programming consists of planning and coding including numerical analysis, systems analysis, specification of printing formats, and any other functions necessary to the integration of a computer in a system.

Punched card—A piece of lightweight cardboard on which information is represented by holes punched in a specific positions.

Real time—The actual time during which a physical process occurs. Pertains to the performance of a computation during the actual time that the related physical process occurs, so that results of the computation can be used in guiding the physical process.

Record—A group of related facts or fields of information treated as a unit. For example, one invoice is a record in a file containing many invoices.

Run—Execute a computer program.

Scanner—That portion of a reading machine having functions of locating materials to be read and converting the optical signal to an electrical signal.

Small business computer—Small, general-purpose computer marketed by mainframers to smaller businesses and first-time users. Prices range from $10,000 to $285,000.

Software—The programs, operating instructions, and other documents that make it possible to use a computer for a specific application.

Source document—An original document from which basic data are taken.

Storage—Pertains to devices capable of retaining data and delivering them on demand at a later time.

Systems analysis—Examination of an activity, procedure, or method to determine what objective is desired, and how operations must be carried out to reach the objective.

Systems programming—Development of programs, such as compilers and operating systems, that control computer operation.

Telecommunications—Transmission of data in the form of signals over long distances via telegraph, radio, or other communications lines.

Terminal—An on-line data entry and display device, usually located away from the central processing unit. If the terminal is 'intelligent', processing devices are built into it and it also can be used for data manipulation.

Throughput—Productivity based on all facets of an operation; e.g., a computer that can read, write, and

compute simultaneously would have a high throughput rating.

Time-sharing—Use of one computer by several independent users.

Unbundling—Marketing method in which the computer vendor sells hardware, software, training, and other services separately rather than as a single package.

Universal Product Code—A standard system of marking for labels, adopted by the major supermarkets, food manufacturers, processors, and distributors for use with computerized checkout equipment.

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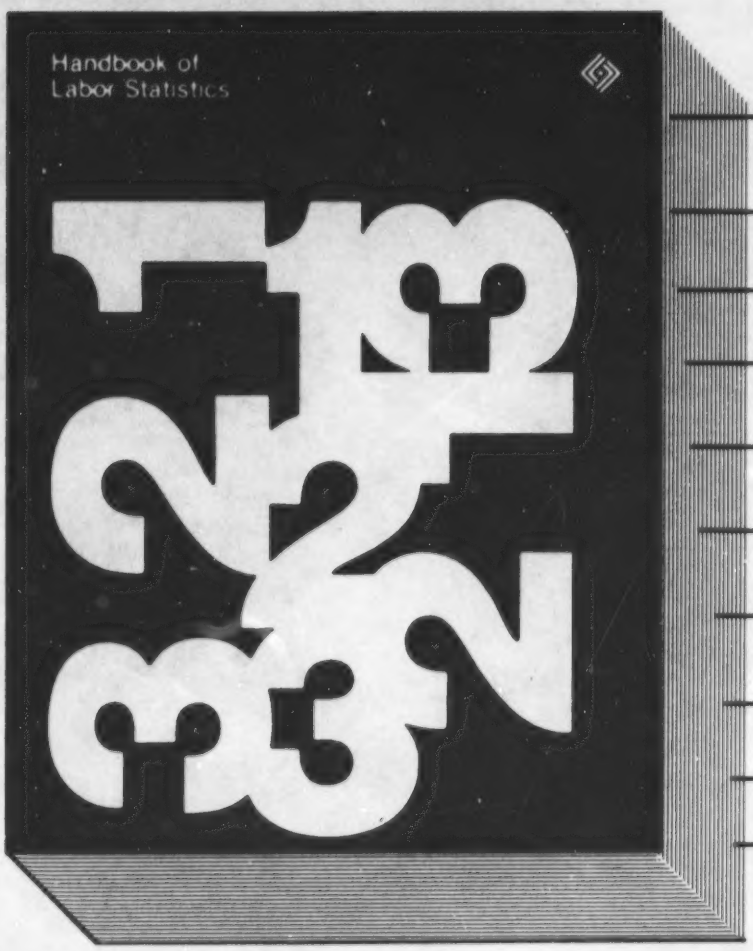

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